

OMAHA DISTRICT
U.S. ARMY
CORPS OF ENGINEERS

File Number
Project Number
Book
Other
12/2/98



FINAL
Site Inspection Report

**Former Building 67
and
Old Dump Site**

**Former Fort Des Moines
Des Moines, Iowa**

December 2, 1998

40093599



SUPERFUND RECORDS

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ABBREVIATIONS

ASTM	American Society for Testing and Materials
BGS	Below Ground Surface
Bldg	Building
B/N/As	Base/Neutral/Acids
BTAG	Biological Technical Assistance Group
BTEX	Benzene, Toluene, Ethylbenzene, Xylenes
°C	Degrees Celsius
CAS	Continental Analytical Services
CENWO	Corps of Engineers, Omaha District
cm	Centimeter
cwm	Clear wide mouth
CV	Cold Vapor
DCE	Dichloroethene
DDD	Dichlorodiphenyldichloroethane
DDE	1,1-Dichloro-2,2-bis-(p-chlorophenyl)ethene
DDT	1,1,1-Trichloro-2,2-bis-(p-chlorophenyl)-ethane
DERP	Defense Environmental Restoration Program
DQCR	Daily Quality Control Report
DQOs	Data Quality Objectives
Dups	Duplicates
EE/CA	Engineering Evaluation/Cost Analysis
EI/RA/AA	Environmental Investigation/Risk Assessment/Alternatives Analysis
eV	Electron volt
Elev.	Elevation (above/below mean sea level)
EPA	Environmental Protection Agency
FSP	Field Sampling Plan
Ft	Foot/Feet
FUDS	Formerly Used Defense Sites
GFAA	Graphite Furnace/Atomic Absorption
HSA	Hollow Stem Auger
IDNR	Iowa Department of Natural Resources
I.D.	Inner Diameter
IDW	Investigative Derived Waste
Kg	Kilogram
L	Liter
LCS	Laboratory Control Sample
LIMS	Laboratory Information Management System
MCL	Maximum Contaminant Level
mg/kg	Milligrams per kilogram
mg/L	Milligrams per Liter, ppm
mg	Milligram
Min	Minute
ml	Milliliters
MR Lab	Missouri River Laboratory
MS/MSD	Matrix Spike/Matrix Spike Duplicate

MSL	Mean Sea Level
N/A	Not Applicable
NOAA	National Oceanic and Atmospheric Agency
O.D.	Outer Diameter
PID	Photoionization Detector
PP	Priority Pollutant (Metals)
ppb	Parts per Billion (measured in water as ug/L)
ppm	Parts per Million (measured in water as mg/L); (measured in soil as mg/kg)
PVC	Polyvinylchloride
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
QCSR	Quality Control Summary Report
R	Rejected
RU	Rejected, less than then detection limit
RAGS	Risk Assessment Guidance for Superfund
RBCs	EPA Region III, Risk Based Concentrations
RCRA	Resource Conservation and Recovery Act
Sec	Second
SSHP	Site Safety and Health Plan
SI	Site Inspection
SOH	Safety & Occupational Health
SOP	Standard Operating Procedure
SOS	Scope of Services
SVOCs	Semivolatile Organic Compounds
SWL	Static Water Level
TBC	To Be Considered
TCE	Trichloroethene
TDS	Total Dissolved Solids
TIC	Tentatively Identified Compounds
TOC	Total Organic Carbon
TRPH	Total Recoverable Petroleum Hydrocarbons
ug/L	Micrograms per Liter, ppb
U.S.	United States
USCS (soil)	Unified Soil Classification System
USACE	United States Army Corps of Engineers
USDA	United States Department of Agriculture
USGS	United States Geological Survey
UST	Underground Storage Tank
VOCs	Volatile Organic Compounds
Yr	Year

EXECUTIVE SUMMARY

The former Fort Des Moines (FDM) consists of a 53.28-acre parcel that represents the major remaining portion of a former U.S. Army cavalry post that was originally established on 640 acres of donated land in 1903. Much of the original property, approximately 557 acres, has already been exscessed and is now used for commercial, residential, and recreational purposes. Former Fort Des Moines (FDM) is an open post located in southern Polk County within the city limits of Des Moines, Iowa and one mile east of the Des Moines International Airport.

PURPOSE AND SCOPE

This report addresses additional Site Inspection (SI) at two FDM sites, Building 67 and the Old Dump Site. These two sites are addressed under the Defense Environmental Restoration Program (DERP) Formerly Used Defense Sites (FUDS), DERP Project No. B071A072900. The purpose of this SI is to evaluate the presence or absence of chemical contamination which may have been caused by Department of Defense (DOD) activities.

Building 67 was formerly utilized as a pesticide mixing facility by a private corporation, Barco Chemical Company, during the years 1950 to 1959. The building structure was demolished in 1962. The current land use for the former Building 67 site is as a parking lot which services the Blank Park Zoo and Blank Park Day Use Area. The Old Dump Site occupies an area of approximately two acres located on the main lake point of Fort Des Moines Reservoir within the confines of Fort Des Moines County Park. The dump was operated from early in the history of FDM to the mid-1960s. While few details about waste types or quantities are available, the dump did receive asbestos, ash from boilers and transformers.

OBJECTIVES

The objectives of this SI are to:

- Obtain additional information concerning the physical environment at each site.
- Determine the presence or absence of previously reported contamination.
- Determine if the contamination has migrated through the soil to the groundwater, or has impacted the soil, sediment or surface water at these sites.
- Evaluate the need for further investigations or responses.
- Perform a risk screen on both sites and to evaluate if any contamination is adversely affecting human health and the environment.

METHODS

Surface soil, subsurface soil, sediment, surface water and groundwater samples were collected from hand- augered borings, soil borings and monitor wells. In addition, a geophysical survey

was conducted at the Old Dump Site for presence of metallic anomalies and to facilitate selection of appropriate sampling locations. At the former Building 67, surface soil, subsurface soil and groundwater were investigated.

The contaminants of concern at the project sites are those associated with the pesticides mixing operation at Building 67 and disposal of construction and/or domestic waste at the Old Dump Site. The project site names and contaminants of concern are detailed as follows:

Project Sites

Former Building 67

Old Dump Site

Contaminants of Concern

Pesticides, VOCs, Metals

VOCs, SVOCs, Pesticides, Herbicides, Metals

Samples for this project were analyzed by Missouri River Laboratory located in Omaha, Nebraska. All methods were from EPA SW-846, Test Methods for Evaluating Solid Waste, 3rd Edition, Update II. The laboratory analytical data was reviewed and verified by the government and contract laboratories (MR Laboratory and Continental Analytical Services) and evaluated by the USACE project chemist for compliance with project objectives.

FINDINGS

The soil contamination encountered at the Building 67 site was primarily pesticides. The most significant exceedances were elevated levels of chlordane, dieldrin, 4,4'-DDD, 4,4'-DDE and 4,4'-DDT. Groundwater contamination encountered at Building 67 primarily consisted of VOCs, SVOCs and pesticides. Lead and arsenic were detected at levels that slightly exceeded IDNR promulgated MCLs. Tetrachloroethene (PCE) in groundwater exceeded both the EPA Region III RBC (tap water) and IDNR MCL.

The primary analytes of concern that were detected in sediment samples at the Old Dump site were pesticides, metals and SVOCs. The analytes alpha BHC, beta BHC, delta BHC, lindane, chlordane, dieldrin, 4,4'-DDT, 4,4'-DDD and 4,4'-DDE were detected in some sediments in concentrations that exceeded the selected screening criteria. The metals arsenic, cadmium, copper, lead, nickel, mercury and zinc were detected in soils at levels greater than the selected screening criteria. The presence of these metals in the sediment and soil data is inconclusive as to whether they are actual contamination or naturally occurring. The semi-volatiles detected were found at concentrations below their respective reporting limits.

BUILDING 67 RECOMMENDATIONS

The recommendations for the Building 67 site are a pre-design investigation in support of an EE/CA for removal of contaminated soil and the development of an EE/CA to remediate contaminated groundwater. The number and distribution of soil samples collected as part of this site investigation are considered to be adequate for calculating soil volumes in support of a removal action. It is anticipated that construction of a reactive barrier wall using zero valence iron will remediate most of the VOCs, pesticides and SVOCs in groundwater.

OLD DUMP SITE RECOMMENDATIONS

Based on the current site use as a park, levels of contamination present and limited exposure pathways, the recommendation for sediments, surface soils and surface water at this site is No Further Action.

1 INTRODUCTION

The Corps of Engineers, Omaha District, performed a Preliminary Assessment/Site Inspection (PA/SI) at the Former Fort Des Moines (FDM), in Des Moines, Iowa. The facility is a Formerly Used Defense Site (FUDS) as defined by the Defense Environmental Restoration Program (DERP). The DERP-FUDS statute [10 USC 2701 (a) (2)] requires that projects addressing hazardous substances, pollutants, and contaminants be conducted consistent with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and the Superfund Amendments and Reauthorization Act of 1986 (SARA). This work effort was performed in accordance with U. S. Environmental Protection Agency Guidance for Performing Preliminary Assessments under CERCLA (EPA/540/G-91/013) and EPA Guidance for Performing Site Inspection under CERCLA (EPA/540-R-92/021).

1.1 PURPOSE

The purpose of this investigation was to collect information concerning physical and chemical conditions of various environmental media at the Former Fort Des Moines sufficient to assess the threat posed by these media to human health and the environment and to determine the need for additional CERCLA action.

1.2 SCOPE

This investigation consisted of the collection of sediment, surface soil, subsurface soil, surface water and groundwater samples for classification and chemical analysis. These environmental media were collected at two sites, the Building 67 and Old Dump sites. In addition, a geophysical survey was conducted to identify the limits of the waste cell at the Old Dump Site. The results of the analytical testing were validated and screened against EPA Region III RBCs for human exposure risks and EPA Region IV RAGs, NOAA ER-L and ER-M criteria for ecological exposure risks as appropriate for specific media.

2 SITE INFORMATION

2.1 SITE HISTORY

Currently, the Former Fort Des Moines (FDM) consists of a 53.28-acre parcel that represents the major remaining portion of a former U.S. Army cavalry post that was originally established on 640 acres of donated land in 1903. Much of the original property, approximately 557 acres, has already been exscessed and is now used for commercial, residential, and recreational purposes.

FDM was used throughout much of its early history as a training camp. It is listed on the National Register of Historic Places because it served as the first training facility for black officers in the U.S. Army and was used as a training center for the Women's Army Auxiliary Corps (WAAC) in 1942. Buildings constructed prior to 1917 are considered to be structures contributing to the overall historical nature of the installation. As a result, such buildings are afforded special protection with respect to demolition activities and the nature and extent of alterations and repairs that may be performed in and on them.

FDM became an induction center for the Army in 1941, and was used as a training center for the WAAC in 1942. The WAAC-related operations occupied a large portion of the former FDM installation that has since been excised. FDM began supporting the Army Reserve Program in 1948, and this activity has continued as the major mission of the installation up to the present time.

In 1988, the U.S. Congress passed the Base Realignment and Closure Act. Fort Des Moines was included on the list for closure. The Fort was closed in 1988.

Former Fort Des Moines (FDM) is an open post located in southern Polk County within the city limits of Des Moines, Iowa and one mile east of the Des Moines International Airport. See Site Vicinity Map on Figure 2-1. The property is bounded by Army Post Road to the north, SE 5th St. to the east, County Line Road to the south and SE 9th St. to the west. See Facility Location Map on Figure 2-2. FDM is currently classified as an inactive sub-installation of Fort McCoy (Sparta, Wisconsin). Its primary mission is to provide support and shelter for the U.S. Army Reserve, and current activities are limited to reserve troop training and maintenance functions performed by six civilian employees stationed in Building 117, the vehicle maintenance shop. Most buildings at FDM are unoccupied or are used for the storage of reserve troop equipment or maintenance equipment.

The current land uses of Former Fort Des Moines property are recreational (Blank Park and Zoo) to the southwest, commercial/residential to the north, residential to the northeast, and recreational (Fort Des Moines County Park) to the southeast. See Property Ownership Map on Figure 2-3.

2.1.1 Former Building 67

Former Building 67 was located on the east margin of the current location of Blank Zoo Park. The site of Building 67, which was demolished in 1962, is located within the confines of the aforementioned park area. This site occupies an area of approximately one quarter of an acre located parallel to Butner Street in the graveled parking lot area of Blank Park Zoo. The dimensions of Building 67 are presumed to have been approximately 50 ft. by 375 ft. See

Figure 2-1. Former Fort Des Moines
Vicinity Map

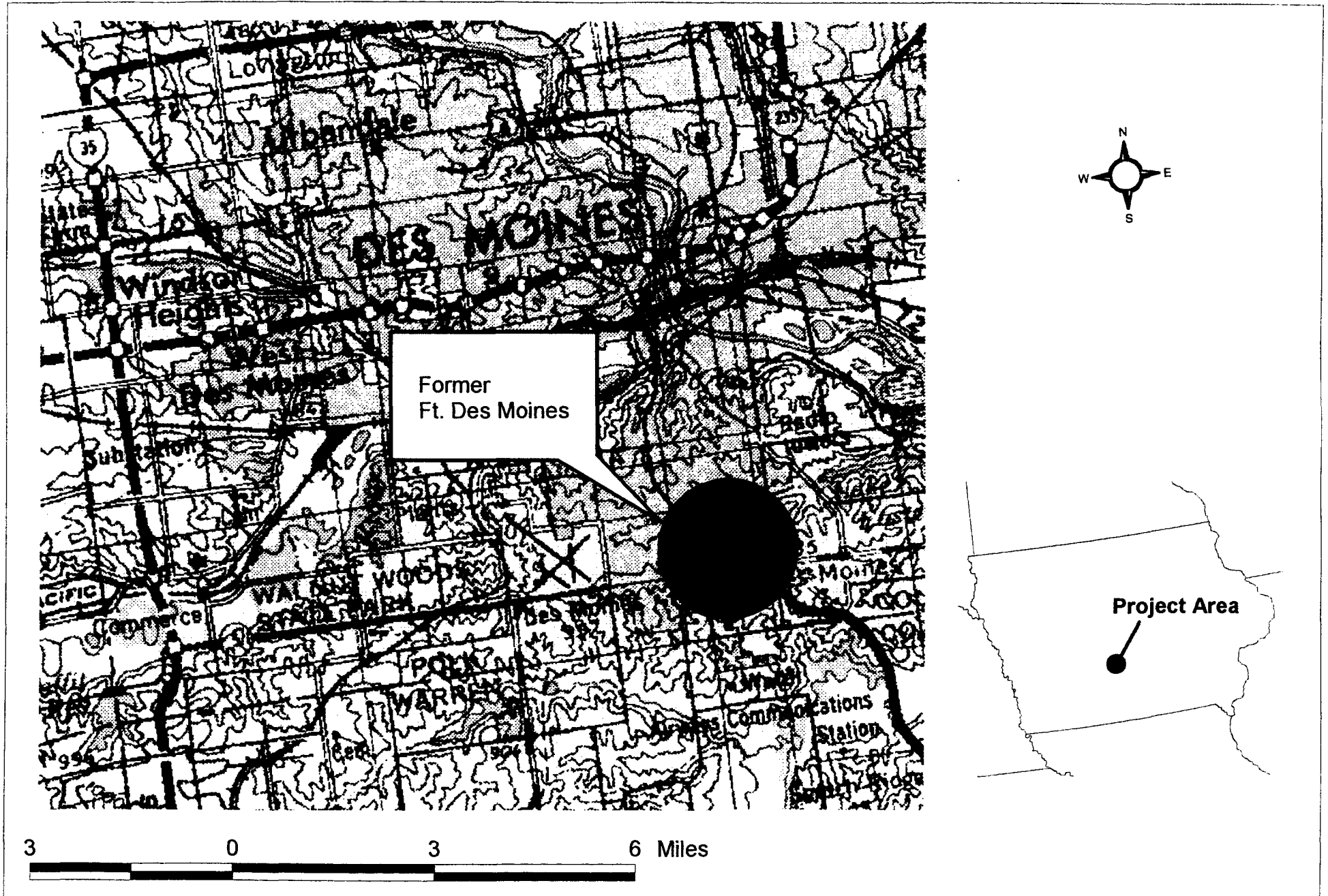


Figure 2-2. Facility Location

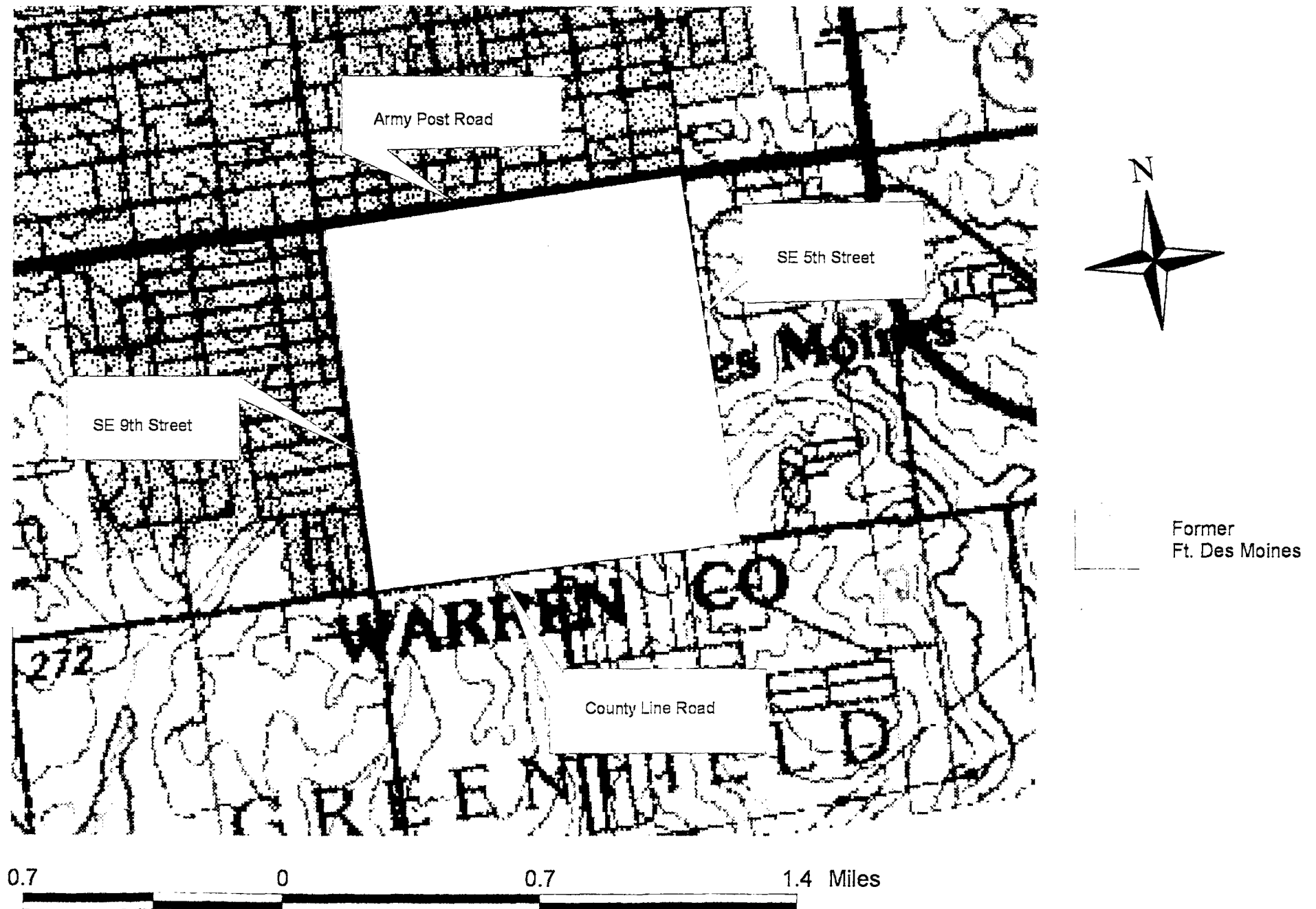
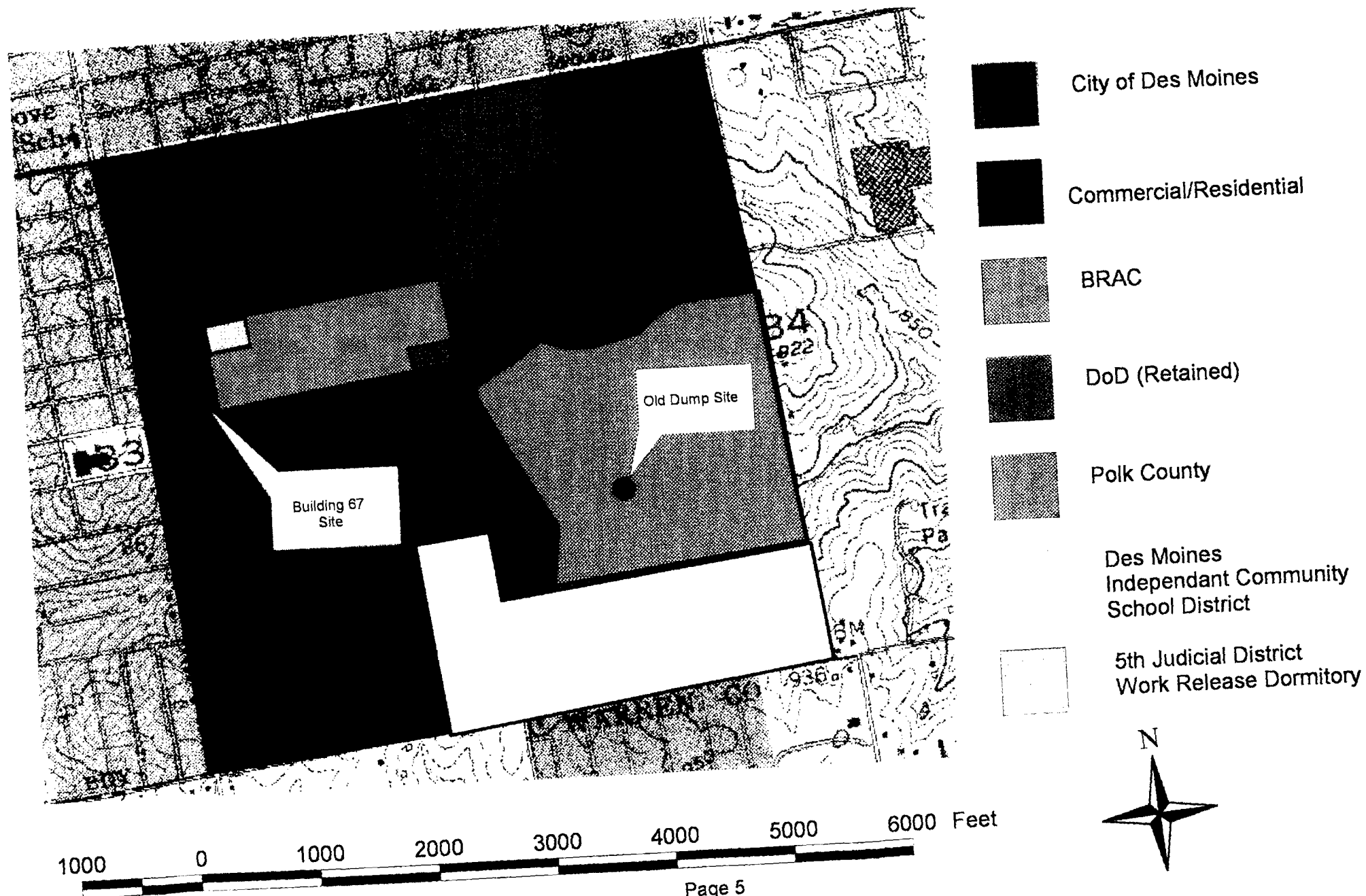


Figure 2-3. Property Ownership Map



Building 67 site map on Figure 2-4. The predominant physical characteristic of this site consists of the presence of a shallow intermittent stream immediately to the west of former Building 67.

The Army previously used Building 67 as a veterinary hospital. This information was determined according to the historical site plan drawing. It is not known what level of veterinary medicine was practiced at the facility nor is it known how long the hospital was in operation by the Army.

The most environmentally significant tenant operation during the history of FDM was the leasing of Buildings 67 and 138 to Barco Chemical Company for pesticide bagging and blending from 1950 to 1959. The site of Building 67 was excessed to the City of Des Moines in 1961. The current land use for the former Building 67 site is as a parking lot which services the Blank Park Zoo and Blank Park (Day Use Area). Building 138 is part of the BRAC property that is currently boarded over and locked to minimize access.

2.1.2 Old Dump Site

The Old Dump Site is located on the west shore of the small reservoir built on the Fort Des Moines County Park. The actual dimensions of the Old Dump Site were not documented, but it occupies an area of approximately two acres located on the main lake point of Fort Des Moines Reservoir within the confines of Fort Des Moines County Park. See Old Dump Site map on Figure 2-5. The predominant physical characteristics of this site consist of the presence of a graveled parking area with a make-shift boat ramp. The site is accessed via a gravel road that originates from the main entrance to Fort Des Moines County Park.

The Old Dump Site was located on property that has been excessed to the Polk County Conservation Board. This area is now utilized as a park/recreation area and there is currently a small reservoir located adjacent to the former dump. The dump was operated from early in the history of FDM to the mid-1960s. While few details about waste types or quantities are available, it is documented that the dump did receive asbestos and ash from boilers and transformers. Reportedly in the past, the sanitary sewage line overflowed into the dump area when the pump station failed. The dump waste is currently covered by a gravel parking lot which serves as the main access for park visitors who fish in the small reservoir that surrounds the site on all but the north site boundary. In addition, a picnic shelter and numerous picnic tables are located in the vicinity of the Old Dump Site to the north.

2.2 PREVIOUS SITE INVESTIGATIONS AT FDM

A series of environmental investigations have been ongoing at FDM since 1983. In November 1983, a Pesticide Monitoring Special Study, Investigation of Possible Contamination Sites was conducted at FDM by Army Environmental Hygiene Agency (AEHA). Soil samples were collected at the former location of Building 67. Metals and low levels of pesticides were detected.

Environmental Science and Engineering Inc. then conducted an Archives Search Report of FDM in January 1985, to determine the potential for on-site existence of toxic and hazardous materials and related contamination. The study included a site visit, identification of contaminants of concern and a detailed site history.

An enhanced Preliminary Assessment was conducted by Roy F. Weston Inc., in October 1989, for FDM within the scope of the U.S. Army Installation Restoration Program (IRP). It was

designed to identify environmentally significant operations (ESOs), characterize the impact of these ESOs on the surrounding environment, and actions that should be taken based on the ESOs. According to the Weston report, no imminent threat to human health existed; however, adverse long-term health effects were possible due to the presence of PCBs, pesticides, and other

Figure 2-4. Building 67
Site Location Map

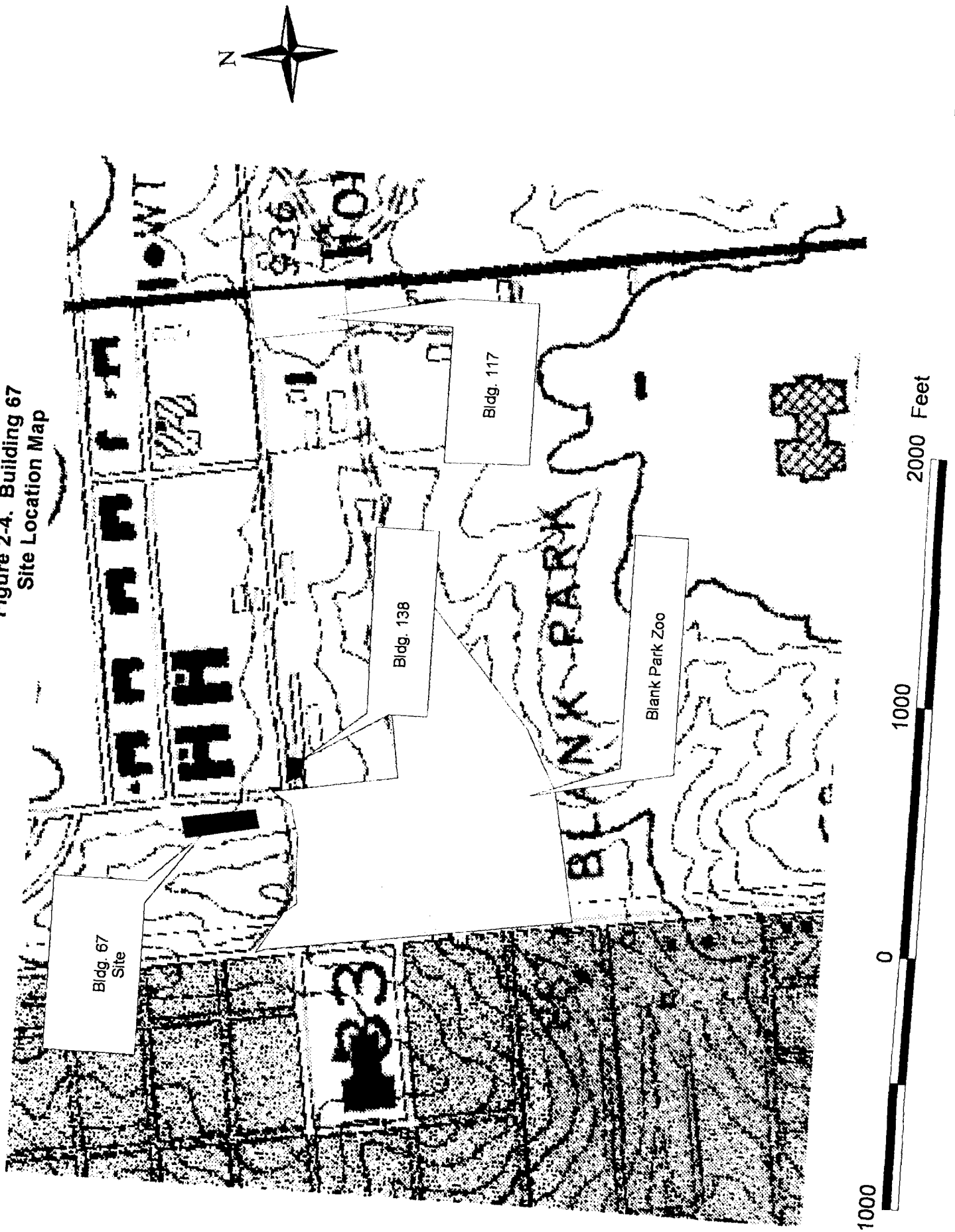
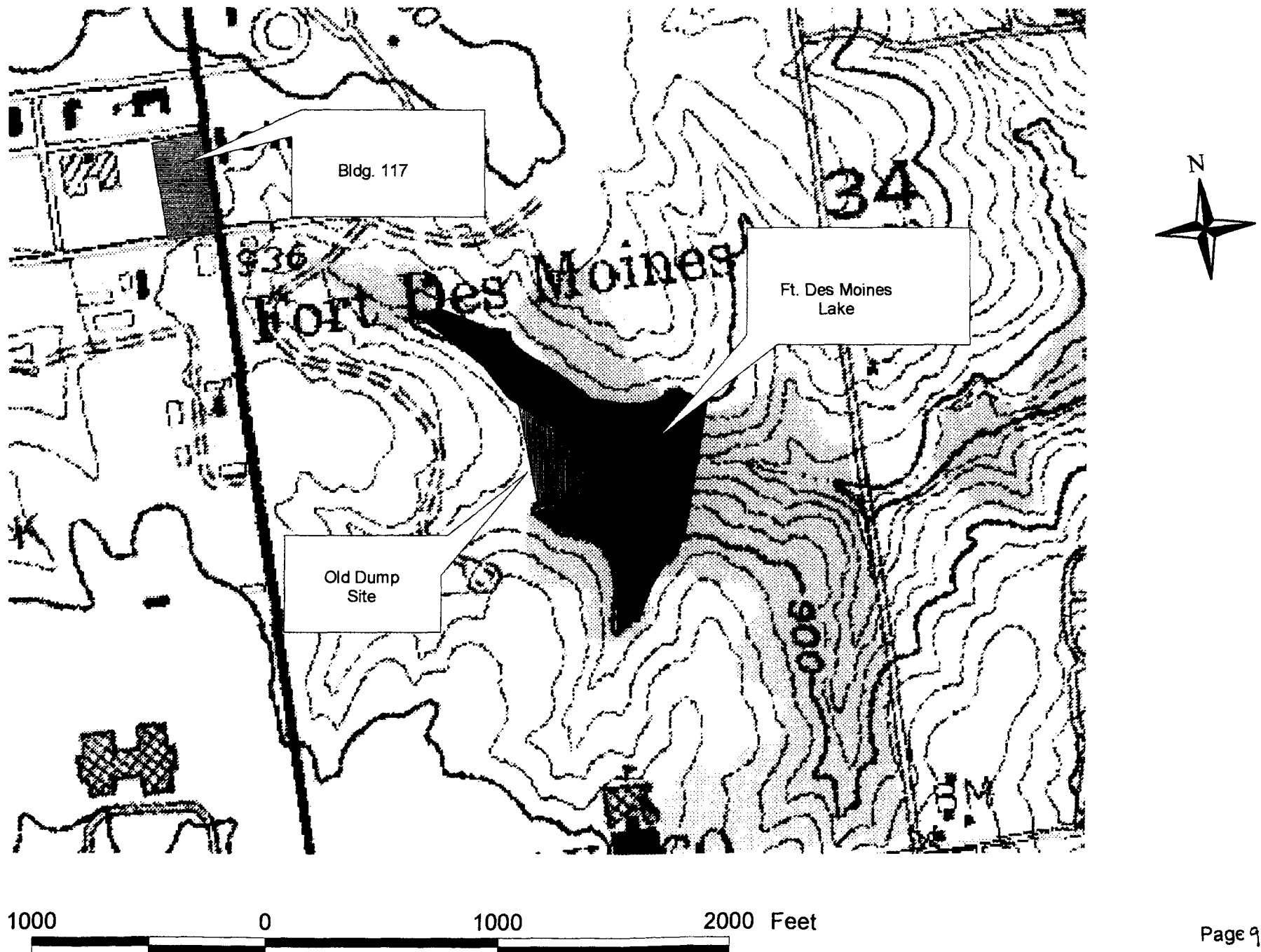


Figure 2-5. Old Dump Site
Site Location Map



items within the unrestricted disposal areas. Weston recommended a more in-depth site investigation of the designated environmentally significant areas.

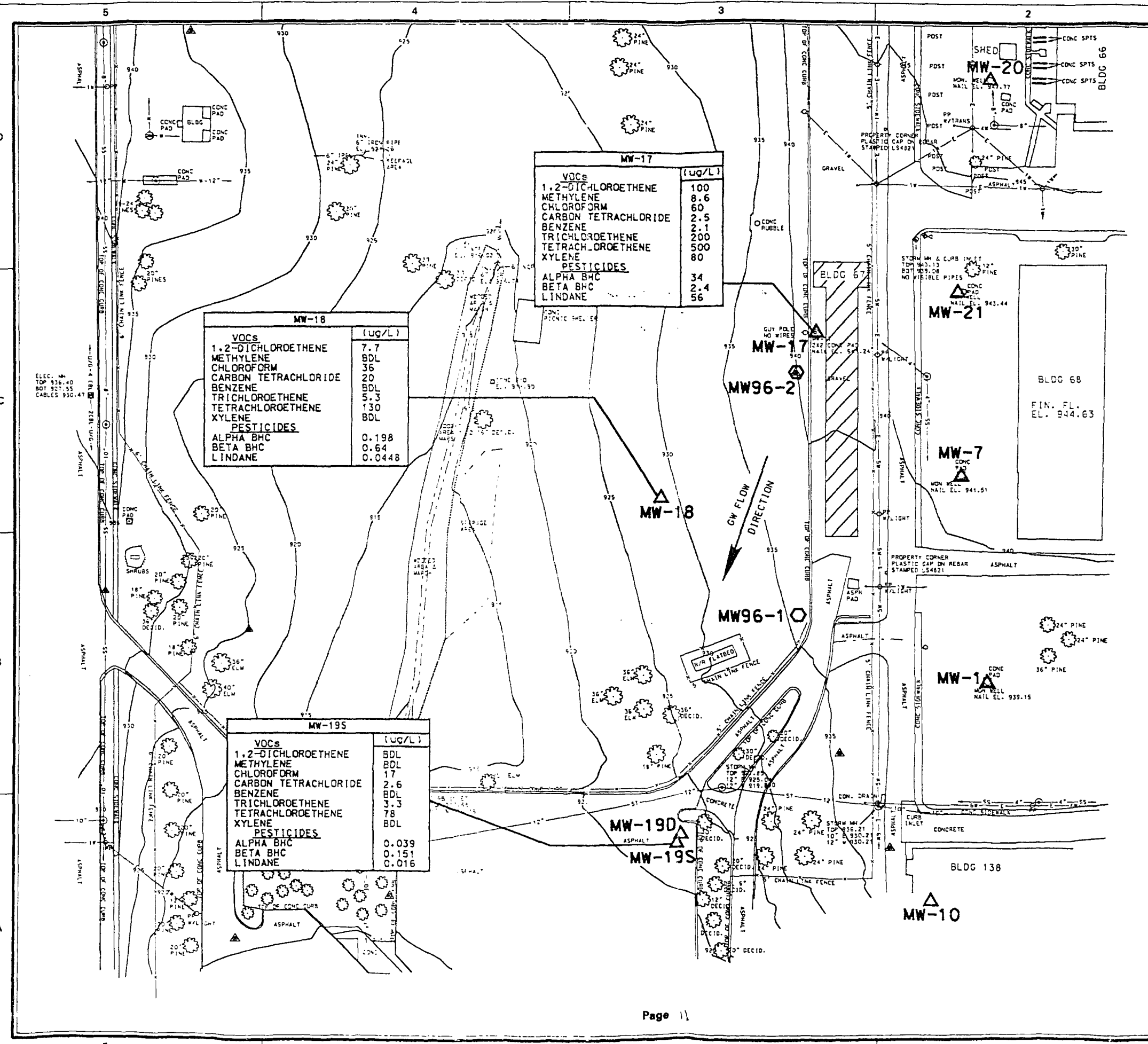
In February 1990, the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA) tasked ICF Technology, Inc. (ICF) to develop a Work Plan for conducting an Environmental Investigation (EI). The plan which was finalized in September 1990, detailed the collection of samples from the designated environmentally significant areas. This work plan was used as the basis for the Versar Final Technical Plan to investigate sites at FDM.

Versar Inc. was contracted by the USACE-Rapid Response Section to conduct an Environmental Investigation/ Risk Assessment/Alternatives Analysis (EI/RA/AA). The Final EI/RA/AA Report, dated July 1995, presents information collected from 1990 through 1993 and was presented for regulatory review in December 1993. Activities involved sampling of USTs, asbestos sampling, radon survey, dust and residue wipe samples of buildings, paint sampling, monitoring well installation, soil gas survey, plus soil, groundwater, sediment and surface water sampling at various sites on FDM. Soil samples were collected at the Building 67 site as part of this investigation to determine off-site impacts related to the BRAC sites activities. The analytical results of these soil samples indicated the presence of various SVOCs, pesticides, and herbicides. The SVOC results were attributed to either the deteriorated gravel lot covering the site or to a nearby asphalt-covered surface.

The Iowa Department of Natural Resources, Fisheries Management Division collected a largemouth bass sample from the Lake surrounding the Old Dump Site which was analyzed for Pesticides (EPA method 8081). Results were presented in a letter dated 8 August 1995, from IDNR Fisheries Management, Mr. Dick McWilliams. Laboratory analysis and the data report were generated by the University of Iowa, Hygienic Laboratory. The elevated DDE concentration detected in the fish tissue sample compared to lake sediment samples probably illustrates the effect of bioaccumulation of this contaminant on a predator species which feeds on bottom-dwelling prey species fish, insects and/or crustaceans. A representative of IDNR, Fisheries Management stated that the levels of contamination detected from their own fish tissue sample analysis indicated that there was not an immediate or long-term health risk to human receptors.

2.2.1 Former Building 67

Soil samples have been collected in 1983 by AEHA and in 1990 by Versar in and around the area formerly occupied by Building 67. In the 1984 AEHA report detectable levels of some metals were found in soil, with lead being present at highest concentrations. See Table 2-1 for analytical results in soil collected by AEHA. In the 1995 Versar report, significant levels of pesticide contaminants in soil were detected. See Table 2-2 for analytical results for soil collected by Versar. Various chlorinated hydrocarbons, pesticides and metals have been detected at elevated concentrations in groundwater up-gradient and down-gradient from the Building 67 site. The groundwater analytical results are presented in Table 2-3, Table 2-4 and Table 2-5. Figure 2-6 illustrates the groundwater sample results for the three shallow wells downgradient from the Building 67 site. The results for the upgradient well, MW-21, are not included because no dissolved chlorinated solvents or pesticides were detected in samples from this well.



- LEGEND**
- TELEPHONE MANHOLE
 - STEAM W. H.
 - FIRE HYDRANT
 - FENCE SYMBOL
 - RAILROAD SYMBOL
 - MONUMENT
 - CLAY VERT END SYMBOL
 - WATER OR POOL LINE
 - DITCH
 - HEAD WALL
 - POWER POLE
 - POLE SUPPORT
 - ELEC MANHOLE
 - ROUND MANHOLE
 - TREE LINE PATTERN
 - STEAM VALVE
 - SIGN
 - DRILL HOLE
 - LIGHT POLE
 - GENERIC TREE SYMBOL
 - STREET LIGHT
 - VERSAR (WELL)
 - USAGE (WELL)

NOTE:
 BDL - BELOW DETECTION LIMIT
 NA - NOT ANALYZED
 ALL DATA COMPILED FROM HISTORICAL
 DATA FROM 1992 TO 1996.
 ONLY THE HIGHEST HISTORICAL
 CONCENTRATION IS REPORTED ABOVE.

US Army Corps of Engineers
 Omaha District

Computer Aided Design & Drafting

SS - THINK VALUE ENGINEERING - SS

Symbol	Description	Date	Approved

U.S. ARMY ENGINEER DISTRICT
 CORPS OF ENGINEERS
 OMAHA, NEBRASKA

Designed by: T.F.J.
 Drawn by: J.A.H.
 Checked by: T.F.J.
 Reviewed by: X
 Submitted by: D.A.C.A. 48
 Date: 06/05/97

Des Moines
 FORMER FORT DES MOINES
 FUDS SITE
SITE MAP
MONITORING WELL LOCATIONS
FIGURE 2-6

Plot Scale Ratio	Date	Sheet Number
1:30	NOVEMBER 1996	

Spec. No.: D.A.C.A. 48
 Drawing Code: X
 Section: D.A.C.A. 48

TABLE 2-1 ANALYTICAL RESULTS FOR SOIL SAMPLES COLLECTED AT FORMER LOCATION OF BUILDING 67

Sample	Concentration (mg/kg or ppm)			
	Cadmium	Chromium	Lead	Mercury
#1	1	14	163	0.06
#2^	<1	24	48	0.05
#3	<1	18	36	0.08
#4	2	15	700	0.05

Note: ^ p,p'-DDE 0.16 ppm and p,p'-DDT 0.03 ppm
Pesticides analyzed for but not detected in Samples 1, 3 and 4.
Source: AEHA, 1984

TABLE 2-2 PESTICIDE AND METAL ANALYTICAL RESULTS FOR SOIL SAMPLES COLLECTED AT FORMER LOCATION OF BUILDING 67

Compound (ug/kg or ppb)	Sample				
	OSBG-7	OSBG-8	OSBG-9	OSBG-10	OSBG-10D
alpha-BHC	6.8	< 2.8	10.7	90.5	134
Aldrin	2.7	<1.4	<1.4	24.1	27.5
beta-BHC	10.1	<7.7	<7.7	74	2011
delta-BHC	<8.5	<8.5	<8.5	15.5	26.1
Dieldrin	37.3	34.2	27.5	1688	2692
Endrin	<6.5	<6.5	<6.5	21	6605
Endosulfan Sulfate	6.4	6.7	4.8	50.6	68.8
Heptachlor	<2.2	<2.2	<2.2	5.6	8.8
Heptachlor Epoxide	4.5	3.9	3.3	17.2	33.2
Lindane	5.0	1.7	8.5	101	112
Methoxychlor	<3.6	<3.6	<3.6	80.7	192
DDD	92.3	<2.7	<2.7	<2.7	<2.7
DDE	1996	1703	92.2	3600	4200
DDT	2419	1849	2171	1700	2600

Compound (ug/kg or ppb)	Sample				
	OSBG-7	OSBG-8	OSBG-9	OSBG-10	OSBG-10D
2,4,5-T	<3.6	<3.6	<3.6	137	<3.6
2,4,5-TP	<20	<20	<20	<20	62.3
2,4-D	<30	<30	<30	204	<30
barium (ppm)	221	194	240	294	534
Cadmium	<1.2	<1.2	<1.2	<1.2	1.6
Chromium	21	16.8	30.2	24.9	40.3
Lead	24	19	20	42	29
mercury (ppm)	0.08	<0.05	0.08	0.11	0.19
manganese (ppm)	969	845	1070	890	2100

Source: Versar, 1995

TABLE 2-3 ANALYTICAL RESULTS FOR ORGANIC COMPOUNDS IN GROUNDWATER AT FORMER LOCATION OF BUILDING 67

Compound	MW-14 9-Feb-93	MW-14D 22-Oct-92	MW-14D 9-Feb-93	MW-17 22-Oct-92	MW-17 9-Feb-93	MW-18 22-Oct-92	MW-18 9-Feb-93	MW-19S 22-Oct-92	MW-19S 9-Feb-93	MW-19D 22-Oct-92
1,2-DCA	<5	<5	<5	100	30	6.7	6.7	<5	<5	<5
Carbon Tetra-chloride	<1	<1	<1	<10	2.5	18	17	2.6	2	<1
Chloroform	<1	<1	<1	60	29	36	22	17	13	<1
PCE	<1	<1	<1	500	200	175	130	78	65	<1
TCE	<1	<1	<1	200	85	5.3	4.3	3.3	2.8	<1
Beta-BHC	<0.0099	<0.0099	<0.0099	5.5	2.4	9.0	0.45	0.15	0.12	<0.0099
Delta-BHC	<0.0034	<0.0034	<0.0034	22	8.9	58.4	0.22	0.07	0.05	<0.0034
lindane	<0.0025	<0.0025	<0.0025	61	29	0.53	<0.0025	0.02	0.016	<0.0025
DDE	<0.0039	<0.0039	<0.0039	0.0478	0.048	<0.0039	<0.0039	<0.0039	<0.0039	0.006
2,4,5-T	<0.16	NA	<0.16	NA	1.25	NA	<0.16	NA	<0.16	NA
2,4,5-TP	<0.095	NA	<0.095	NA	0.337	NA	<0.095	NA	<0.095	NA
2,4-D	<0.263	NA	<0.263	NA	2.76	NA	0.306	NA	<0.263	NA

Versar, 1995
Results in ug/l or ppb

1,2-DCA = 1,2-dichloroethane
PCE = tetrachloroethene
TCE = trichloroethene
2,4,5-T = 2,4,5-trichlorophenol
2,4,5-TP = 2,4,5-trichlorophenoxy propionic acid
2,4-D = 2,4-dichlorophenoxyacetic acid

**TABLE 2-4 ANALYTICAL RESULTS FOR INORGANIC COMPOUNDS IN
GROUNDWATER AT FORMER LOCATION OF BUILDING 67**

Compound	2 x Back- ground Average	MW-14 9-Feb-93	MW-14D 22-Oct- 92	MW-14D 9-Feb-93	MW-17 22-Oct- 92	MW-17 9-Feb-93	MW-19S 22-Oct- 92	MW-19S 9-Feb-93	MW-19D 22-Oct- 92
Aluminum	23,870	5680	24900	8030	28900	74600	2720	3510	10100
Barium	387.5	151	290	128	660	1000	87.6	66.3	405
Calcium	204,800	84700	116000	109000	340000	260000	72700	64900	460000
Copper	41.55	<18.8	42.3	<18.8	44	82.3	49.8	<18.8	50.9
Iron	47,875	7150	62000	14400	55800	138000	7820	6300	64800
Lead	13.29	<4.47	13.4	<4.47	16.5	41.6	9.45	<4.47	23.7
Manganese	1,210	452	886	225	2830	3860	696	2080	4170
Mercury	0.1275	<0.1	0.105	<0.01	0.106	0.183	<0.01	<0.01	<0.01
Nickel	56	<32.1	63.9	<32.1	79.7	145	57.8	<32.1	60.8
Zinc	152.2	23	192	47.5	105	283	32.2	22.5	46

Versar, 1995
Results in ug/l

TABLE 2-5 ANALYTICAL RESULTS FOR QUARTERLY GROUNDWATER SAMPLES

Compound	MW-14 5-June-96	MW-14D 5-June-96	MW-17 7-June-96	MW-18 7-June-96	MW-19S 7-June-96	MW-19D 7-June-96
1,2-DCA	<1	<1	<1	<1	<1	<1
Carbon Tetrachloride	<1	<1	<1	1.4	<1	<1
Chloroform	<1	<1	6.48	9.92	1.16	<1
PCE	<1	<1	34.8	9.94	15.7	<1
TCE	<1	<1	14.9	<1	<1	<1
Alpha-BHC	<0.01	<0.01	14.0	<0.01	0.023	<0.01
Beta-BHC	<0.01	<0.01	2.34	0.323	0.177	<0.01
Delta-BHC	<0.01	<0.01	6.88	0.136	0.045	<0.01
Lindane	<0.01	<0.01	13.5	0.047	0.045	<0.01
DDE	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
2,4,5-T	<0.10	<0.10	286	<0.10	<0.10	<0.10
2,4,5-TP	<0.10	<0.10	<100	<0.10	<0.10	<0.10
2,4-D	<0.10	<0.10	145	<0.10	<0.10	<0.10
Barium	<2	<2	378	<2	<2	<2
Calcium	60500	102000	247000	25600	42500	NA
Lead	4.83	<3.0	3.14	<1.02	<1.02	NA
Manganese	<1.2	<1.2	3810	<1.2	217	NA
Magnesium	26200	33400	137000	12600	18800	NA
Sodium	8910	8700	25500	7580	7940	NA

OHM, 1996

Results in ug/l

1,2-DCA = 1,2-dichloroethane

PCE = tetrachloroethene

TCE = trichloroethene

2,4,5-T = 2,4,5-trichlorophenol

2,4,5-TP = 2,4,5-trichlorophenoxy propionic acid

2,4-D = 2,4-dichlorophenoxyacetic acid

2.2.2 Old Dump Site

Samples of soil were taken in the landfill area and they indicated detectable levels of DDE, DDT, and chlordane as well as cadmium, chromium, lead and mercury (AEHA 1984). Lake sediment samples were also taken with low levels of pesticides being detected. Metals were detected in one lake sediment sample, also at low levels. See Table 2-6 for analytical results.

The Iowa Department of Natural Resources, Fisheries Management Division report stated that these fish tissue samples indicated elevated concentrations of DDE (0.073 mg/kg) and Methoxychlor (0.22 mg/kg) only. All other analytes were below quantitation limits. A summary of the analytical data is presented in Table 2-7.

TABLE 2-6 ANALYTICAL RESULTS FOR SOIL AND SEDIMENT SAMPLES COLLECTED FROM THE FORMER OLD DUMP AND THE SURROUNDING LAKE

Sample Location	Pesticide	Concentration (mg/kg or ppm)
#10 Soil at Landfill	p,p'-DDE	0.02
	p,p'-DDT	0.04
#11 Soil at Landfill	p,p'-DDE	0.03
	p,p'-DDT	0.06
#12 Lake Sediment	p,p'-DDD	0.03
	p,p'-DDT	0.06
#13 Lake Sediment	p,p'-DDD	0.03
	p,p'-DDE	0.02
	p,p'-DDT	0.04 - 0.10
	cis-chlordane	0.008
#14 Lake Sediment	Cadmium	< 1
	Chromium	< 14
	Lead	< 71
	Mercury	< 0.07

Source: U.S. Army Environmental Hygiene Agency (USAEHA). 1984. "Pesticide Monitoring Special Study No. 17-44-0986-84. Investigation of Possible Contamination Sites, FDM, Iowa." Iowa Department of Natural Resources Files: CON 12-15 Abandoned or Uncontrolled Sites, Fort Des Moines

**TABLE 2-7 ANALYTICAL RESULTS FOR BIOASSAY (FISH TISSUE) SAMPLES
COLLECTED FROM THE FORMER OLD DUMP AND THE SURROUNDING LAKE**

Sample Location	Pesticide	Concentration (mg/kg or ppm)
Ft. Des Moines Lake (Largemouth Bass)	DDE	0.73
	Methoxychlor	0.22

Source: IDNR, Fisheries Management, "Letter from Mr. Dick McWilliams". Laboratory analysis and data report was generated by the University of Iowa, Hygienic Laboratory, dated 8 August 1995.

3 INVESTIGATION ACTIVITIES

3.1 RATIONALE OF PROJECT EXECUTION

In order to determine whether a release had occurred, key target environmental media were investigated. These media included surface soil, sediment, and surface water at the Old Dump Site. In addition, a geophysical survey was conducted to pre-screen the Old Dump Site for presence of metallic anomalies and to facilitate selection of appropriate surface soil, sediment and surface water sampling locations. At the former Building 67, surface soil, subsurface soil and groundwater were investigated.

Upon completion of the geophysical survey, the data generated was reviewed and considered for its impact on preliminary sampling locations. Where appropriate sampling locations were moved to either avoid large anomalies or to enhance the likelihood of collecting representative samples. In addition, the distribution of metallic anomalies were mapped to illustrate the areal extent of metallic debris present at the Old Dump Site. Due to the fact that the Old Dump Site is immediately adjacent to a reservoir, it was determined that down gradient monitor wells would provide little or no benefit to characterization of groundwater. In addition, since it is highly likely that there is hydraulic communication between groundwater within the waste cell of the former dump and surface water impounded by the reservoir, it is likely that this relationship between groundwater and surface water would adversely impact the installation of monitor wells in that: a) it would be difficult to determine if groundwater samples from potential wells located along the down-gradient perimeter of the dump would be representative of groundwater within the waste cell; b) it would be difficult to install a monitoring well along the perimeter of the dump due to the low topographic relief of the dump relative to the elevation of surface water in the reservoir; c) it would be impractical to install monitor wells along the perimeter of the dump due to the presence of concrete hardfill within the waste cell and d) the safety issues associated with drilling directly in a dump waste cell could not be overcome through engineering controls.

Finally, soil borings and monitoring wells were located at the Building 67 Site based on visual evidence of past investigation of the BRAC area to the east (including Building 138) and historical background information. The number of soil borings and monitoring wells and their distribution around each site were intended to provide enough data to determine whether any contaminant releases have occurred. As much information about vertical and lateral extent of contamination was gathered, and it was determined to the extent possible, the groundwater flow direction and gradient at Building 67.

3.1.1 Site Investigation Sampling Rationale - Former Building 67

Previous investigation of this site revealed that elevated volatiles, pesticides and metals concentrations were present at and near Building 67 in the soil and groundwater. Table 2-5, shows results for the quarterly groundwater sampling. It was determined that additional soil and groundwater samples were needed to adequately characterize contamination directly resulting from Building 67 activities. Characterization at this site was accomplished by advancing nine soil borings around the perimeter of the assumed former footprint of Building 67 and installing two additional monitor wells downgradient from the former Building 67. Three soil samples from each of the nine boreholes (a total of twenty-seven soil samples) were collected for chemical analysis. In addition, three duplicate soil samples as well as one duplicate groundwater sample were collected and submitted for analysis.

3.1.2 SI Sampling Rationale - Old Dump Site

Previous investigation of this site revealed that elevated pesticides and metals concentrations were present in lake sediment. It was determined that additional surface soil, sediment and surface samples were needed to adequately characterize contamination which might be related to Old Dump Site disposal activities. Characterization at this site was accomplished by using a stainless steel hand auger to collect surface soil and sediment samples around the perimeter of the dump disposal area as identified by the geophysical survey that was conducted at this site. In addition, one surface water sample was collected immediately adjacent to the boat ramp dock on the southwest edge of the site in order to characterize the surface water.

3.2 GENERAL

Surface soil, subsurface soil, sediment, surface water and groundwater samples were collected from hand augered borings, soil borings and monitor wells. In addition, a geophysical survey was conducted at the Old Dump Site. The field procedures used to perform all sampling activities were accomplished as specified in the Ft. Des Moines SI Sampling and Analysis Plan (SAP) dated July 5, 1996, and prepared by USACE-Omaha, except as noted in the following sections.

3.3 SITE PREPARATION

Prior to sampling, each site was inspected and sample locations were marked with labeled stakes. Where necessary, sample locations were offset from the proposed locations due to field conditions. Any changes to sampling locations were documented on boring logs and the field log book. Utility clearances were obtained prior to initiation of all intrusive work.

3.4 GEOPHYSICAL SURVEY

The geophysical survey was performed by Braun Intertec from Minneapolis, MN. Under contract with Braun Intertec, Geosphere Midwest conducted the EM-61 and Magnetometer surveys according to manufacturer's operator manual instructions and the contracted scope of services. The survey consisted of setting up a site grid boundary, pushing the appropriate instrument over the site on either 5 feet or 2.5 feet grid spacings and logging the raw data which was subsequently transferred to a personal computer where the data could be manipulated to produce maps depicting the presence or absence of metallic anomalies and their areal distribution across each site.

3.5 SURFACE SOIL SAMPLING

A stainless steel hand auger was used to collect surface soil samples. The hand auger was advanced to a depth of 6 inches below ground surface at each designated sample location. The soil was placed in a stainless steel bowl where it was homogenized and placed in sample containers as detailed in the SAP for surface samples. All sampling equipment was decontaminated between sample locations as detailed in the SAP for surface sampling methods.

3.6 SEDIMENT SAMPLING

A stainless steel hand auger was used to collect sediment samples. The hand auger was advanced to a depth of 6 inches below the pond basin at each designated sample location. The soil was placed in a stainless steel bowl where it was homogenized and placed in sample containers as detailed in the SAP for sediment samples. All sampling equipment was

decontaminated between sample locations as detailed in the SAP for sediment sampling methods.

3.7 SUBSURFACE SOIL SAMPLING

Drilling was accomplished by using a Gus Pech 1100c equipped with 4.25-inch (Inside Diameter) hollow stem augers. A 3.0 inch (outside diameter) stainless steel split-spoon sampler was driven a distance of 2.0 feet from ground surface to the bottom depth of each boring. These sampling intervals were considered to be adequate to determine the vertical extent of soil contamination at each site. A surface soil sample was collected from 0-2 feet in each boring. An intermediate subsurface sample was collected from 4-6 feet unless headspace screening indicated the presence of volatiles or visible evidence of hydrocarbon stained soil was observed in the 2-4 feet interval. If groundwater was encountered in any particular interval, then the sample collected immediately before the saturated interval was submitted for chemical analysis as the deep subsurface sample. The bottom-most sample was collected from the 8-10 feet interval, unless otherwise compelled by headspace analysis or soil staining from hydrocarbons, and was submitted as the deep subsurface soil sample. Subsurface soil samples were collected and prepared for shipment to the lab as is specified in the SAP. All drilling tools were decontaminated with a steam cleaner. Sampling equipment was decontaminated as specified in the SAP. A copy of all boring logs generated from this investigation are included as Appendix A.

3.8 SURFACE WATER SAMPLING

Surface water samples were collected by emersing a chemically inert, clean, one-gallon polyethylene jug into the reservoir and subsequently decanting this water into appropriate sample containers. Preservatives were added to each sample container according to the required analysis. The samples were then placed in ice filled coolers and prepared for shipment to the lab, per SAP guidance.

3.9 MONITORING WELL INSTALLATION

Two of the soil borings, MW96-1 and MW96-2, were completed as monitor wells after they were advanced at least 7 to 8 feet below the first encounter of groundwater. Generally, most monitor well borings were drilled to a depth of 15 to 30 feet below ground surface. Approximately 1 foot of 20/40 Colorado Silica Sand was placed in the bottom of the boring, followed by the lowering of the 2-inch nominal diameter P.V.C. riser pipe and 10 feet long, .010 slot continuous wire wrap P.V.C. screen. The remaining well annulus was backfilled with 20/40 Colorado Silica Sand to approximately 2 feet above the top of the screen interval, followed by a 2 feet thick (before hydration) interval of bentonite pellet seal. The seal was hydrated as specified in the SAP and the well boring left open to allow proper seal hydration overnight before final completion. After adequate bentonite seal hydration had occurred, the remaining annulus was grouted with bentonite/cement grout to within 1 to 2 feet of the ground surface. The grout was allowed to settle and partially cure prior to installation of the surface completion of each well. Surface completions consisted of installing a 2 feet diameter concrete collar, extending a minimum of 4 inches above grade, around a flush finish well vault. Well completion diagrams are provided in Appendix B.

Due to the lack of groundwater inflow responsiveness, the monitoring wells were not developed as specified in the SAP. A sufficient volume of water was not available for proper well

development at the time of installation. It was determined by the USACE project geologist that since these monitor wells were installed in a marginal aquifer (at best) failed to respond with sufficient inflow to warrant development, and that off-setting did not produce more responsive aquifer conditions, that development was not of paramount importance especially since low-flow sampling methodologies would be employed.

3.10 GROUNDWATER SAMPLING

Monitor wells were purged prior to sampling as specified in the SAP, except as noted below. Wells were purged with a Grundfos Rediflo 2 submersible pump using disposable polyethylene tubing. Groundwater parameters were monitored for indication of parameter stability and subsequently recorded on purge/sample records and the field log book. Turbidity of the groundwater was measured and in both wells was greater than 200 NTUs. Since most of the monitor wells installed during this investigation were constructed in shallow glacial till aquifers that typically produce relatively turbid groundwater at slow recharge velocities, it was decided that low flow (minimal drawdown) groundwater purging and sampling was preferable to collecting filtered and unfiltered samples for metals analysis. Hence, the purging and sampling procedures were modified to incorporate low flow purging and sampling procedures proposed by the EPA in EPA/540/S-95/504. A copy of EPA/540/S-95/504 is provided in Appendix D. The well purge/sample records are provided in Appendix C.

Groundwater samples were collected as specified in the SAP and as noted above. After the monitor wells were sufficiently purged, the pump controller was adjusted such that the pump discharged groundwater at the lowest flow (100-250 ml/min.) possible for sampling. Groundwater samples collected by directly discharging water from the pump discharge tubing into the appropriate sample containers. Each container was pre-filled with an adequate volume of preservative and was checked again for proper concentration of preservative after filling with groundwater sample. The pH was checked by pouring a small amount of the sample into the lid of the container, then dipping pH paper into the lid. The sample contained in the lid was then disposed of on the ground. This procedure, however, was not performed on samples for VOC analysis. As sample containers were filled, they were immediately capped and placed in an ice filled cooler for chilling. Samples were held on site for less than 24 hours before being packed for shipment to the analytical laboratory.

3.11 DOCUMENTATION OF FIELD ACTIVITIES

A field log book was utilized for documentation of all field activities, including drilling, well installation, well development and groundwater sampling. Geologic drill logs and well construction diagrams were developed for all boreholes and monitor wells, respectively. Daily Quality Control Reports (DQCRs) were completed daily by the field geologist. The field log books and DQCRs were retained as part of the project file. The drill logs and well completion diagrams are provided in Appendices A and B.

3.12 DECONTAMINATION AND IDW HANDLING PROCEDURES

Decontamination of drilling equipment was executed as specified in the SAP. A decontamination pad was established in the graveled lot adjacent to the Building 67 site for cleaning all drilling tools and vehicles. Decontamination of groundwater sampling equipment consisted of a non-phosphate detergent wash followed by a tap water and a distilled water rinse.

Soil and water IDW that was generated as a result of this investigation was disposed of on-site. Soil cuttings were scattered after drilling soil borings or construction of monitor wells. Development, purge and decontamination waters, and all settleable solids were discharged to the ground surface on-site at a location determined not to drain back towards a borehole or monitor well.

3.13 SURVEYS

Surface soil, soil boring and monitor well sample locations were surveyed using the National Geodetic Vertical Datum of 1983 for vertical control and the Iowa State Plane Coordinate System for horizontal control.

3.14 ANALYTICAL METHODS

Samples for this project were analyzed by Missouri River Laboratory located in Omaha, Nebraska. (Please note that in September 1998, the name of the Missouri River Laboratory was changed to Chemical Quality Assurance Lab, CQAL). All methods were from EPA SW-846, Test Methods for Evaluating Solid Waste, 3rd Edition, Update II.

All of the samples from the Former Building 67 site were analyzed by the following methods:

Soil Matrix

<u>Analyte</u>	<u>Method, EPA SW846</u>
antimony (Sb), barium (Ba), cadmium, (Cd), chromium, (Cr), copper (Cu), nickel (Ni), silver (Ag), zinc (Zn), selenium (Se), zinc (Zn)	3050/6010A
arsenic (As), lead (Pb), thallium (Tl)	7000 series, G.F.
mercury (Hg)	7471, C.V.
Pesticides	8081
Herbicides	8150
Volatile Organic Compounds	8260

Groundwater Matrix

<u>Analyte</u>	<u>Method, EPA SW846</u>
Sb, Ba, Cd, Cr, Cu, Ni, Ag, Zn, Se, Zn	3005/6010A
As, Pb, Tl	7000 series, G.F.
Hg	7471, C.V.
Pesticides	8081
Herbicides	8150
VOC	8260

All of the samples from the Old Dump Site were analyzed by the following methods:

Soil and Sediment Matrix

<u>Analyte</u>	<u>Method, EPA SW846</u>
Sb, Ba, Cd, Cr, Cu, Ni, Ag, Zn, Se, Zn	3050/6010A
As, Pb, Tl	7000 series, G.F.
Hg	7471, C.V.
Pesticides	8081
SVOC	3550/8270A
VOC	8260

Surface Water Matrix

<u>Analyte</u>	<u>Method, EPA SW846</u>
Sb, Ba, Cd, Cr, Cu, Ni, Ag, Zn, Se, Zn	3005/6010A
As, Pb, Tl	7000 series, G.F.
Hg	7471, C.V.
Pesticides	8081
SVOC	8270A
VOC	8260

4 PHYSICAL FEATURES OF THE STUDY AREA

4.1 CLIMATE

The climate at this site is that of a continental climate characterized by wide seasonal variations in temperature and precipitation. Winters are cold and dry while the summers are warm and wet. The average daily maximum temperature, computed on an annual basis is approximately 59° F while the average daily minimum temperatures 38° F. January and February are the coldest months, with July and August being the warmest. The average annual precipitation is approximately 30 inches per year of both rain and snow combined. The months of May and June are the months of highest precipitation, all in the form of rain. Prevailing winds are from the south in summer but from the northwest during the winter.

4.2 PHYSIOGRAPHY

Former Fort Des Moines lies in the Central Lowland Province. The project sites fall within the Dissected Till Plains section. The southern-most boundary margin of the Western Lakes section lies immediately to the north of former Fort Des Moines. The characteristic features of these physiographic divisions resulted from glaciation of different periods, ranging from as young as the Cary (Wisconsinan) drift in the Western Lakes section north of the site to as old as the Nebraskan drift which underlies the site(s). In general, the surficial glacial till deposition resulting from the Wisconsinan Stage forms the land features indicative of the Western Lakes section and the surficial Wisconsinan Loess covered Kansan Till deposition is indicative of the Dissected Till Plains section. The unconsolidated materials encountered in the Dissected Till Plains section consists primarily of clayey and silty fine sands to sandy and silty clays near surface which represent loess deposition. Underlying the loess deposits is a silty to sandy clay till with occasional lenses of sand and/or gravel which represents Kansan Till deposition. The hills and narrow upland plains of this division were formed by the dissection of a glacial drift plain that was later covered to various depths by wind-laid formations known as Peorian Loess (upper).

4.3 GEOLOGY

The glacial till beneath the sites ranges in textural composition from clay to sand. This till can best be described as a clay with trace amounts of silt, sand and gravel, with occasional sand stringers (glacial outwash). The oxidized till is generally brownish gray with orange mottling common. This relatively thin layer of till is overlain by a locally, thicker layer of loess.

The thickness of the loess is a function of the topography of both the land surface and upper surface of the glacial till. The thickness of the eolian deposit varies significantly across the site. The site is located less than 4 miles from the Bemis Terminal Moraine (Wisconsinan Stage) which was most likely responsible for the loess deposition. It is estimated to range from <5 to 20 feet thick in the Fort Des Moines area. The loess is most commonly a silt or fine sand with appreciable clay fines. It is yellow brown with occasional orange mottling. It is stiff to loose with low plasticity.

4.4 SOILS

The topsoils have been classified as belonging to the Downs silt loam on the relatively flat lying areas, Ladoga silt loam on slope of 2 to 30 % and Gara loam on 5 to 20 % slopes on topographically lower land surfaces. The Downs and Ladoga silt loams are typically associated

with loess deposition and range from 3 to 4 feet thick on side slopes and 8 to 20 feet thick on flat lying areas. The Gara loam soils are usually associated with relatively thin (4 to 6 feet thick) Kansan till. Pennsylvanian aged shale bedrock is typically encountered below the Kansan till deposits. Due to the uneven weathered surface of the Kansan till deposits and Pennsylvanian shale weathered bedrock, it is possible that Kansan till may be absent in some localities.

4.5 SOIL CHEMISTRY

Soil is the end-product resulting from the physical, chemical and biological alteration and/or degradation of geologic parent material (rocks and sediments). The soil system is a highly heterogeneous matrix of inorganic and organic components. The relative proportions of these components are dependent upon factors influencing soil formations, such as topography, climate, depositional processes, and time (Sposito, 1984). The total concentration of metals in soil varies from one area to another, primarily due to the soil-forming processes. For example, in one area soils may form primarily as a result of the leaching process (degradation), whereas, in another area soils may form primarily as a result of a mechanical weathering process (disintegration). More often than not, however, soils form as a result of multiple processes. The one factor that seems to have the greatest influence on the relative presence or absence of specific naturally occurring concentrations of metals is the chemical composition of the parent material from which the soil is formed. It is for these reasons that, when metals contamination is suspected, judicious interpretation of metals concentration data is of great importance.

In addition, site-specific background concentrations were calculated by Versar (1995) for screening soil sample concentrations as well as groundwater. Versar calculated background soil conditions for TAL metals, pesticides, SVOCs, herbicides and Dioxins/Furans but for the purposes of this report only their calculated metals background concentrations were considered. The basis of the Versar calculated background concentrations consisted of the collection of four (4) surface soil samples, obtained from the 0 to 1.5 ft. below ground surface interval, which were analyzed for the previously identified list of analytical suites. An average concentration was calculated from the four samples for each analyte. Per EPA Region VII authorization, two times the average concentration of each analyte was reported for screening purposes. The following table (Table 4-1) portrays expected concentration ranges, published geometric mean for the general area in and around Des Moines, IA and site-specific 2 X average concentration values as calculated by Versar (1995).

Sample analytical results were compared to background concentrations of metals in soil. Any results showing concentrations greater than background were then screened against EPA Region III risk-based concentrations. If any analytes failed the risk-based screening criteria, they were then considered worthy of consideration as a site related contaminant.

TABLE 4-1 IOWA BACKGROUND METALS CONCENTRATIONS IN SOIL

ANALYTE	RANGE (mg/kg)	GEOMETRIC MEAN (mg/kg)	Site-Specific¹ 2 X Average Conc. (mg/kg)
Antimony	0 - <1.0	0.48	19.6
Arsenic	4.6 - 6.6	5.2	14.7
Barium	500 - 700	440 *	457
Beryllium	<1 - 2.0	NC	1.75
Chromium	50 - 70	37*	42.5
Copper	30 - 700	17*	37.9
Lead	15 - 700	16	60.7
Mercury	0.032 - 0.13	0.058	14
Nickel	20 - 700	13	43.4
Selenium	<0.1 - 5.0	0.26	NC
Zinc	45 - 3,500	48	20.1

Note: Reference is Elemental Concentrations in Soils and Other Surficial Materials of the Conterminous United States (USGS Professional Paper 1270).

* Mean results fall outside range because only the range of concentrations within 60 miles of Des Moines, IA were selected for inclusion, whereas the means were calculated on a state-wide basis.

¹Calculated by Versar, Inc. EI/RA/AA in 1995.

4.6 HYDROGEOLOGY

4.6.1 Surface Water

The major bodies of surface water near Fort Des Moines are the Des Moines and Raccoon Rivers. The confluence of these two rivers lies approximately four miles to the north of Fort Des Moines. The City of Des Moines draws most or all of its municipal water supply from the Des Moines River.

The surface water drainage of Building 67 is to the west and southwest via lamellar flow until it reaches an unnamed tributary to Blank Park Creek. This unnamed tributary is an ephemeral stream that appears to derive all of its source water from surface run-off. Blank Park Creek is a tributary to the North River.

The surface water drainage of the Old Dump Site is via lamellar flow to a small reservoir which surrounds the disposal area on three sides. During periods of excessive precipitation, the surface water flows over the dam spillway to the southeast into an unnamed ephemeral stream. This ephemeral stream flows to the southeast into the North River.

In general, drainage from the western and southern portions of Fort Des Moines is to the southwest via Blank Park Creek to the North River. Drainage from the eastern half of Fort Des Moines is to the southeast via an unnamed tributary of the North River. The North River converges with the Des Moines River approximately 6 miles east of Fort Des Moines.

4.6.2 Ground Water

Groundwater is available in the surficial and deep aquifers in the Fort Des Moines area. Water levels in the surficial aquifer generally range between 3 and 15 meters b.g.s. The utility of these

surficial aquifers is questionable, however, because wells installed in these aquifers typically suffer from poor yields ($0.001 \text{ m}^3/\text{sec}$ or less) and are highly mineralized. The bedrock aquifers are usually much higher yielding (up to 0.03 to $0.06 \text{ m}^3/\text{sec}$ greater in the Cambro-Ordovician Aquifer than in the surficial aquifer) and produce water of better quality with respect to mineral content. The City of Des Moines' supply of municipal water is from wells tapping the Cambro-Ordovician Aquifer which yield $0.11 \text{ m}^3/\text{sec}$ and from the Des Moines and Raccoon Rivers.

During the Environmental Investigation conducted by Versar, Inc., groundwater flow within the surficial aquifer was found to generally mimic surface topography. Groundwater flow within the surficial aquifer and upper bedrock material was also found to flow predominantly to the south and southwest in the vicinity of Building 67. Due to the distance and surficial aquifer flow direction relative to the location of the Des Moines River (four miles north of the site), it is highly unlikely that there is any hydraulic communication between the surficial aquifer at Fort Des Moines and the Des Moines River.

The groundwater encountered in the surficial aquifer was found to be hard (due to the natural occurrence of calcium and magnesium constituents in the water-bearing unit) and contains undesirable concentrations of sulfates, nitrates and bacteria. The occurrence of sulfates and nitrates may be attributed to the high intensity use of agricultural chemical residues or occur naturally. The sites impacted by pesticides contamination (i.e. Building 67 and Building 138) have also adversely affected the water quality of the surficial aquifer. However, despite the fact that groundwater in the surficial aquifer has been impacted by the contaminant releases documented to have occurred at Fort Des Moines, it is also fair to say that regionally high background concentrations of pesticides, fertilizers and other residual waste greatly restricts the potential use of the surficial aquifer. Laws dating back to the early 1900's were created to condemn wells deemed to produce water unfit for human consumption in response to outbreaks of cholera and typhoid. As a result, most of the surficial aquifer wells within the City of Des Moines have been abandoned. In addition, all Des Moines residents are required to utilize the municipal water supply system for public health reasons. The Hydrogeologic Units underlying Fort Des Moines is presented in Table 4-2.

TABLE 4-2 HYDROGEOLOGIC UNITS

Geologic Unit	Unit Description	Geologic Age	Aquifer Characteristics
Glacial Till	Clay tills with sand and/or gravel outwash.	Quaternary	Shallow Aquifer
Des Moines Series	Alternating shale and limestone with minor sandstone and coal.	Pennsylvanian	Upper Aquifer
St. Louis Limestone	Limestone and dolostone with some chert.	Mississippian	Middle Aquifer
Osage Series	Dolomitic shale.		
Kinderhook Series	Limestone and dolostone with some chert nodules.		
		Silurian	
Maquoketa Formation	Gray-green shale, dolostone and chert.	Ordivician	Confining Unit
St. Peter Sandstone	Consists of coarse to fine, rounded and frosted sand grains with minor green shale stringers.		Lower Aquifer
Prairie Du Chien Formation	Upper: sand dolostone.		
	Middle: sandstone.		
	Lower: oolitic dolostone.		
Jordan Sandstone	Consist of fine to medium, well sorted and frosted sand grains.	Cambrian	
St. Lawrence Formation	Coarsely crystalline and silty dolostone.		

5 SITE INVESTIGATION RESULTS

5.1 ANALYTICAL RESULTS - FORMER BUILDING 67

The following discussions will summarize analytical results by sample matrix. All analytical results have been tabulated with a comparison to EPA Region III RBCs, both industrial and residential, for surface and subsurface soil. Groundwater analytical results have been tabulated with a comparison to EPA Region III RBCs and IDNR promulgated MCLs. Only the results that exceed either RBCs or MCLs are shown in the discussions in this section. The data presented in the following sections and the remaining bulk data is tabulated and provided as Appendix E.

5.1.1 Surface and Subsurface Soil

Soil samples were analyzed for volatile organics, pesticides, metals, and herbicides. The analytical results for surface and subsurface soils indicated that various volatile organic compounds, pesticides and metals concentrations were either elevated above EPA Region III RBCs or EPA Region III BTAG screening values. Presence of these contaminants in the vadose zone soils indicates that they are possible sources of groundwater contamination. The samples that exceed EPA Region III RBCs or EPA Region III BTAG screening values or that are suspected sources for groundwater contamination are provided in Table 5-1 and Figure 5-2.

The lithology at this site consists of a surficial cohesive unit made up primarily of lean (CL) to borderline fat (CL/CH) or fat clays (CH) interpreted as glacial till which grades into a non-cohesive silty sand (SM-ML) to sandy gravelly silt (ML) at approximately 18 to 20 feet below ground surface. It is unknown how extensive the non-cohesive unit is since only two borings were drilled greater than 10 feet bgs. However, based on the fact that both well borings encountered this unit it is expected that the unit is locally extensive.

5.1.1.1 Volatile Organic Compounds

The results of VOC analysis indicated the presence of tetrachloroethene, methylene chloride and carbon tetrachloride. Tetrachloroethene (PCE) was present in borings SB96-06, SB96-07, SB96-08 and SB96-09 with concentrations that ranged from 3.3J $\mu\text{g/kg}$ to 380 $\mu\text{g/kg}$. The concentrations of PCE encountered did not exceed EPA Region III RBCs but did exceed the BTAG ecological value of 300 $\mu\text{g/kg}$. These results are presented because the groundwater samples collected at this site indicated PCE concentrations that exceed RBCs and/or IDNR MCLs. The exceedance of these screening levels in groundwater and presence in vadose zone soils indicates that a source for PCE is present at this site. Methylene chloride was also detected but at very low concentrations and it was also detected in the method blanks. Carbon tetrachloride was detected in boring SB96-07 at the 8 foot sample interval with a concentration of 5.8 $\mu\text{g/kg}$, which is well below the industrial RBC of 44000 $\mu\text{g/kg}$.

5.1.1.2 Pesticides

Several pesticides, alpha BHC, beta BHC, chlordane, 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, chlordane and dieldrin, were detected in the soil samples at varying concentrations and depths.

Alpha BHC was present in boring SB96-08 at a concentration of 130 $\mu\text{g/kg}$ in the 2 feet sample interval. This did not exceed the industrial RBC of 910 $\mu\text{g/kg}$, and there is not an EPA Region III BTAG screening value.

Beta BHC was present in boring SB96-08 at 2' at concentration of 550 µg/kg which did not exceed the industrial RBC of 3200 µg/kg, and there is not an EPA Region IIIBTAG screening value.

Chlordane was present in borings SB96-01 and SB96-08 at concentrations ranging from 62 µg/kg to 19,000 µg/kg. Only the sample from SB96-08 exceeded the industrial RBC of 16000 µg/kg. But, samples from SB96 -01, -05, -07, and -08 exceeded the EPA Region IIIBTAG screening value of 100 µg/kg.

4,4'-DDD was present in borings SB96-01, -02, -05, -07 and SB96-08 at concentrations ranging from 14 µg/kg to 5,500 µg/kg. The results for 4,4'-DDD indicated that all concentrations were below the industrial RBC of 24,000 µg/kg. Samples from borings SB96-01, -05, and -08 exceeded the EPA Region III BTAG screening value of 100 µg/kg.

4,4'-DDE was present in borings SB96-01, -02, -05, -07 and SB96-08 at concentrations ranging from 13 µg/kg to 2,400 µg/kg. The results for 4,4'-DDE indicated that all concentrations were below the industrial RBC of 17,000 µg/kg. Samples from borings SB96-01, -05, and -08 exceeded the EPA Region III BTAG screening value of 100 µg/kg.

4,4' -DDT was present in borings SB96-01, -02, -03, -05, -06, -07 and SB96-08 at concentrations ranging from 13 µg/kg to 26,000 µg/kg. The results for 4,4'-DDT indicated that concentrations which exceeded the industrial RBC of 17,000 µg/kg occurred in the 4 feet sample interval in SB96-05 (26,000 µg/kg), and in the 2 feet sample interval in SB96-08 (20,000 µg/kg). Samples from borings SB96-01, -05, and -08 exceeded the EPA Region III BTAG screening value of 100 µg/kg.

Dieldrin was present in borings SB96-01, -02, -05, -07 and SB96-08 at concentrations ranging from 11 µg/kg to 1,400 µg/kg. The results for Dieldrin indicated that concentrations which exceeded the industrial RBC of 360 µg/kg occurred in the 2 feet sample interval in SB96-01 (1100 µg/kg), in the 4 and 10 feet sample intervals in SB96-05 (1400 µg/kg and 750 µg/kg respectively), and in the 2 feet sample interval in SB96-08 (570 µg/kg). Samples from borings SB96-01, -05, and -08 exceeded the EPA Region IIIBTAG screening value of 100 µg/kg.

5.1.1.3 Herbicides

Herbicides were analyzed for, but were not detected above the laboratory detection limits.

5.1.1.4 Metals

The results of metals analysis indicated the presence of arsenic, beryllium, chromium, copper, lead, nickel, zinc, and mercury. Only arsenic exceeded the Region III RBCs for ingestion of 3.8 mg/kg in all soil samples. Concentrations of arsenic ranged from 8.8 mg/kg to 11.9 mg/kg. Beryllium, chromium, copper, lead, nickel, zinc and mercury had detections that exceeded the EPA Region III BTAG Screening values of 0.02, 0.02, 15, 2, 2, 10, and .058 mg/kg respectively, but were less than the Region III RBCs.

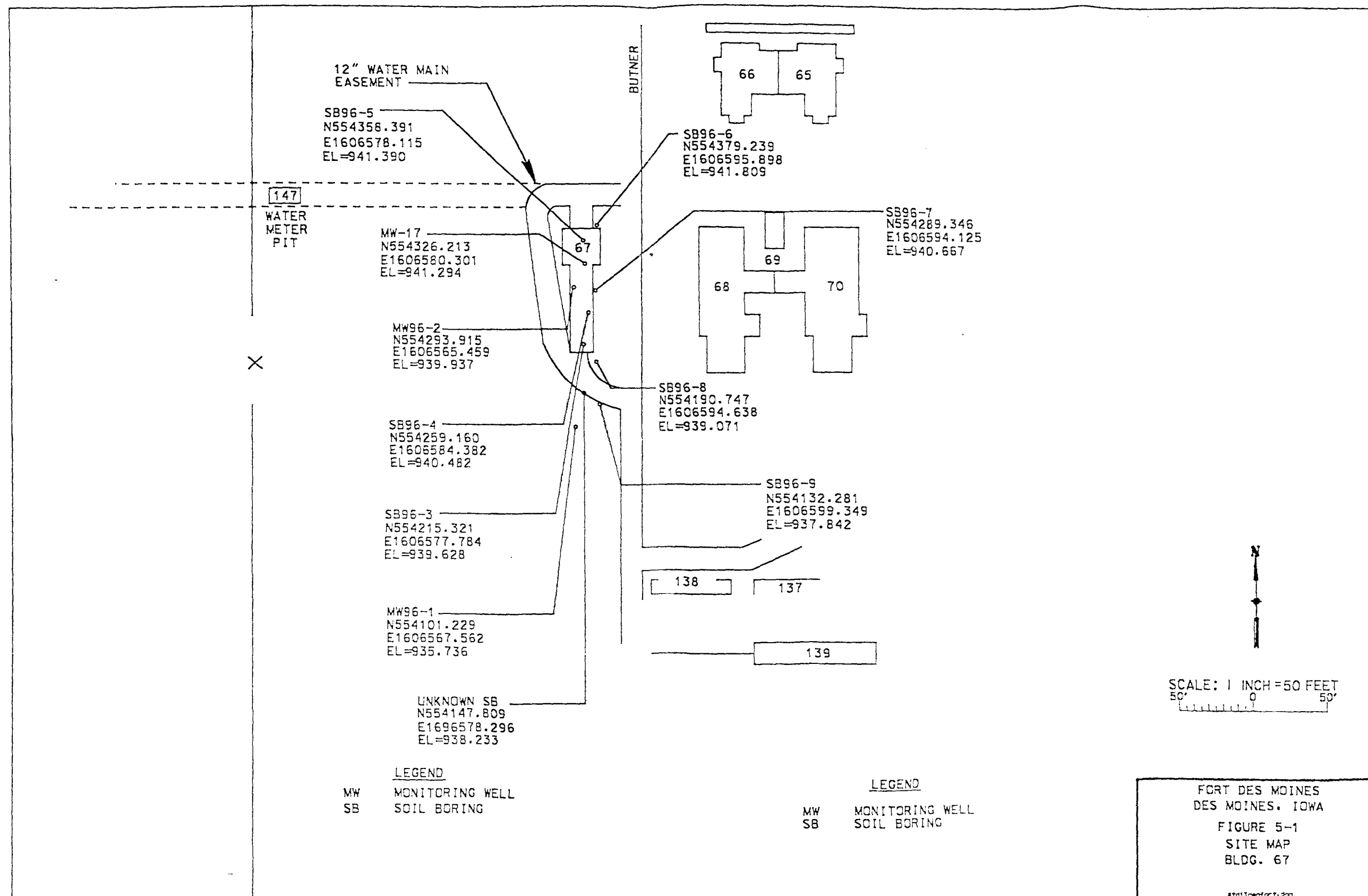


TABLE 5-1 SUMMARY OF SOIL SAMPLE RESULTS, BUILDING 67

Sample #	Depth (ft)	Analyte	Concen- -tration	Units	EPA Region III, Industrial RBC	EPA Region III BTAG
SB96-01	2	Beryllium	0.6	mg/kg	4100	0.02
		Chromium	19.8		3100000	0.02
		Copper	18.7		82000	15
		Lead	22.5		none	2
		Nickel	22.3		41000	2
		Zinc	80.9		610000	10
		Arsenic	9.7		3.8	32.8
		Chlordane	420	ug/kg	16000	100
		4,4'-DDT	2200		17000	100
		4,4'-DDD	340		24000	100
		4,4'-DDE	880		17000	100
		Dieldrin	1100		360	100
	6	Beryllium	0.7	mg/kg	4100	0.02
		Chromium	20.8		3100000	0.02
		Copper	21.2		82000	15
		Lead	11		none	2
		Nickel	26.9		41000	2
		Zinc	82.1		610000	10
		Arsenic	9.8		3.8	32.8
	10	Beryllium	0.5	mg/kg	4100	0.02
		Chromium	19		3100000	0.02
		Copper	19.6		82000	15
		Lead	10		none	2
		Nickel	24.9		41000	2
		Zinc	74.9		610000	10
		Arsenic	8.8		3.8	32.8
		Mercury	0.6		None	0.058
SB96-02	6	Beryllium	0.7	mg/kg	4100	0.02
		Chromium	25.6		3100000	0.02
		Copper	20.4		82000	15
		Lead	13		None	2
		Nickel	26		41000	2
		Zinc	73.6		610000	10
		Arsenic	11.4		3.8	32.8
	8	Beryllium	0.5	mg/kg	4100	0.02
		Chromium	17.8		3100000	0.02
		Copper	19.6		82000	15
		Lead	13.6		None	2
		Nickel	31.4		41000	2
	8	Zinc	71.2		610000	10
			33			

Sample #	Depth (ft)	Analyte	Concen- -tration	Units	EPA Region III, Industrial RBC	EPA Region III BTAG
		Arsenic	10.2		3.8	32.8
	10	Beryllium	0.5	mg/kg	4100	0.02
		Chromium	16.4		3100000	0.02
		Copper	19.4		82000	15
		Lead	13.4		None	2
		Nickel	27.5		41000	2
		Zinc	66.9		610000	10
		Arsenic	10.6		3.8	32.8
SB96-03	6	Beryllium	0.8	mg/kg	4100	0.02
		Chromium	20.1		3100000	0.02
		Copper	20.6		82000	15
		Lead	14.7		None	2
		Nickel	22.7		41000	2
		Zinc	75.3		610000	10
		Arsenic	9.9		3.8	32.8
	8	Beryllium	0.7	mg/kg	4100	0.02
		Chromium	18.7		3100000	0.02
		Copper	18.9		82000	15
		Lead	15.6		None	2
		Nickel	28.2		41000	2
		Zinc	71.4		610000	10
		Arsenic	10.2		3.8	32.8
	10	Beryllium	0.6	mg/kg	4100	0.02
		Chromium	18.9		3100000	0.02
		Copper	18.8		82000	15
		Lead	12		None	2
		Nickel	23.3		41000	2
		Zinc	70.6		610000	10
		Arsenic	9.6		3.8	32.8
SB96-04	4	Beryllium	0.8	mg/kg	4100	0.02
		Chromium	21		3100000	0.02
		Copper	20.6		82000	15
		Lead	15.9		None	2
		Nickel	20.9		41000	2
		Zinc	72.9		610000	10
		Arsenic	11.6		3.8	32.8
	6	Beryllium	0.7	mg/kg	4100	0.02
		Chromium	18.1		3100000	0.02
		Copper	20.9		82000	15
		Lead	15.6		None	2
	6	Nickel	28.5		41000	2

Sample #	Depth (ft)	Analyte	Concen- -tration	Units	EPA Region III, Industrial RBC	EPA Region III BTAG
	10	Zinc	78.9	mg/kg	610000	10
		Arsenic	11.1		3.8	32.8
		Beryllium	0.5		4100	0.02
		Chromium	18.1		3100000	0.02
		Copper	16.4		82000	15
		Lead	11.9		None	2
		Nickel	20.9		41000	2
		Zinc	68.3		610000	10
		Arsenic	8.3		3.8	32.8
SB96-05	2	Beryllium	0.6	mg/kg	4100	0.02
		Chromium	19.9		3100000	0.02
		Copper	20.7		82000	15
		Lead	22.8		None	2
		Nickel	22.7		41000	2
		Zinc	84		610000	10
		Arsenic	10.7		3.8	32.8
		Chlordane	810	ug/kg	16000	100
		4,4'-DDD	310		24000	100
		4,4'-DDE	440		17000	100
		4,4'-DDT	1300		17000	100
		Dieldrin	180		360	100
	4	Beryllium	0.7	mg/kg	4100	0.02
		Chromium	19.9		3100000	0.02
		Copper	21.7		82000	15
		Lead	23.7		None	2
		Nickel	25		41000	2
		Arsenic	9.6		3.8	32.8
		Zinc	93.9		610000	10
		Chlordane	12000	ug/kg	16000	100
		4,4'-DDD	5500		24000	100
		4,4'-DDE	2300		17000	100
		4,4'-DDT	26000		17000	100
		Dieldrin	1400		360	100
	10	Beryllium	0.6	mg/kg	4100	0.02
		Chromium	19.1		3100000	0.02
		Copper	18.1		82000	15
		Lead	26.4		None	2
		Nickel	23.6		41000	2
		Zinc	76.6		610000	10
		Arsenic	9.2		3.8	32.8
	10	Chlordane	5300	ug/kg	16000	100

Sample #	Depth (ft)	Analyte	Concen- -tration	Units	EPA Region III, Industrial RBC	EPA Region III BTAG
		4,4'-DDD	2600		24000	100
		4,4'-DDE	820		17000	100
		4,4'-DDT	12000		17000	100
		Dieldrin	750		360	100
SB96-06	4	Beryllium	0.6	mg/kg	4100	0.02
		Chromium	18.5		3100000	0.02
		Copper	15.9		82000	15
		Lead	16.2		None	2
		Nickel	19.5		41000	2
		Zinc	61.5		610000	10
		Arsenic	10.3		3.8	32.8
	6	Beryllium	0.7	mg/kg	4100	0.02
		Chromium	20.7		3100000	0.02
		Copper	20.1		82000	15
		Lead	14.8		None	2
		Nickel	26		41000	2
		Zinc	67.9		610000	10
		Arsenic	12		3.8	32.8
	8	Beryllium	0.7	mg/kg	4100	0.02
		Chromium	18.5		3100000	0.02
		Copper	22.8		82000	15
		Lead	15		None	2
		Nickel	99.1		41000	2
		Zinc	65.2		610000	10
		Arsenic	10.1		3.8	32.8
SB96-07	2	Beryllium	0.6	mg/kg	4100	0.02
		Chromium	17.6		3100000	0.02
		Lead	15.5		None	2
		Nickel	19		41000	2
		Zinc	61.6		610000	10
		Arsenic	8.6		3.8	32.8
	6	Beryllium	0.6	mg/kg	4100	0.02
		Chromium	18.2		3100000	0.02
		Copper	20.6		82000	15
		Lead	15.5		None	2
		Nickel	28.8		41000	2
		Zinc	77.2		610000	10
		Arsenic	12		3.8	32.8
		Chlordane	300	ug/kg	4400	100
	8	Beryllium	0.5	mg/kg	4100	0.02
	8	Chromium	18.9		3100000	0.02

Sample #	Depth (ft)	Analyte	Concen- -tration	Units	EPA Region III, Industrial RBC	EPA Region III BTAG
		Copper	19.4		82000	15
		Lead	13.6		None	2
		Nickel	29.2		41000	2
		Zinc	69.8		610000	10
		Arsenic	10.8		3.8	32.8
	2	Beryllium	0.7	mg/kg	4100	0.02
		Chromium	18		3100000	0.02
		Copper	16.3		82000	15
		Lead	36.6		None	2
		Nickel	22.2		41000	2
		Zinc	76.8		610000	10
		Chlordane	19000	ug/kg	4400	100
		4,4'-DDD	4300		24000	100
		4,4'-DDE	2400		17000	100
		4,4'-DDT	20000		17000	100
		Dieldrin	570		360	100
		Lindane	140		4400	100
SB96-08	6	Beryllium	0.7	mg/kg	4100	0.02
		Chromium	18.1		3100000	0.02
		Copper	21.1		82000	15
		Lead	14.7		None	2
		Nickel	23.8		41000	2
		Zinc	66.5		610000	10
		Arsenic	9.9		3.8	32.8
	10	Beryllium	0.6	mg/kg	4100	0.02
		Chromium	17.5		3100000	0.02
		Copper	17.7		82000	15
		Lead	13.5		None	2
		Nickel	23.1		41000	2
		Zinc	57.9		610000	10
		Arsenic	9		3.8	32.8
		Chlordane	100	ug/kg	16000	100
SB96-09	2	Beryllium	0.5	mg/kg	4100	0.02
		Chromium	15		3100000	0.02
		Lead	16.4		None	2
		Nickel	20.8		41000	2
		Zinc	54.9		610000	10
		Arsenic	7		3.8	32.8
	6	Beryllium	0.7	mg/kg	4100	0.02
		Chromium	21		3100000	0.02
	6	Copper	20.8		82000	15

Sample #	Depth (ft)	Analyte	Concentration	Units	EPA Region III, Industrial RBC	EPA Region III BTAG
		Lead	17		None	2
		Nickel	22.1		41000	2
		Zinc	68.4		610000	10
		Arsenic	10.3		3.8	32.8
	10	Beryllium	0.6	mg/kg	4100	0.02
		Chromium	17.7		3100000	0.02
		Copper	19.1		82000	15
		Lead	13.7		None	2
		Nickel	24.9		41000	2
		Arsenic	9.6		3.8	32.8
		Zinc	71.5		610000	10

Note: Concentrations in ug/kg are equivalent to parts per billion (ppb) and mg/kg are equivalent to parts per million (ppm).

SB96-05 SOIL RESULTS				
	DEPTH (FT)	ANALYTE	AMOUNT	UNITS
PESTICIDES	2	CLORDANE	810	ug/kg
	2	DIELDRIN	180	ug/kg
	4	CLORDANE	12000	ug/kg
	4	4,4'-DDD	5500	ug/kg
	4	4,4'-DDE	2300	ug/kg
	4	4,4'-DDT	26000	ug/kg
	4	DIELDRIN	1400	ug/kg
	10	CLORDANE	5300	ug/kg
METALS	10	4,4'-DDT	12000	ug/kg
	10	DIELDRIN	750	ug/kg
	2	BERYLLIUM	0.6	mg/kg
	4	BERYLLIUM	0.7	mg/kg
	10	BERYLLIUM	0.6	mg/kg

SB96-07 SOIL RESULTS				
	DEPTH (FT)	ANALYTE	AMOUNT	UNITS
VOLATILES	8	TETRACHLOROETHENE	190	ug/kg
PESTICIDES	2	DIELDRIN	73	ug/kg
METALS	2	BERYLLIUM	0.6	mg/kg
	6	BERYLLIUM	0.6	mg/kg
	8	BERYLLIUM	0.5	mg/kg

SB96-02 (MW96-2) SOIL RESULTS				
	DEPTH (FT)	ANALYTE	AMOUNT	UNITS
METALS	6	BERYLLIUM	0.7	mg/kg
	8	BERYLLIUM	0.5	mg/kg
	10	BERYLLIUM	0.5	mg/kg

SB96-04 SOIL RESULTS				
	DEPTH (FT)	ANALYTE	AMOUNT	UNITS
METALS	4	BERYLLIUM	0.8	mg/kg
	6	BERYLLIUM	0.7	mg/kg
	10	BERYLLIUM	0.5	mg/kg

SB96-03 SOIL RESULTS				
	DEPTH (FT)	ANALYTE	AMOUNT	UNITS
METALS	6	BERYLLIUM	0.8	mg/kg
	8	BERYLLIUM	0.7	mg/kg
	10	BERYLLIUM	0.6	mg/kg

SB96-01 (MW96-1) SOIL RESULTS				
	DEPTH (FT)	ANALYTE	AMOUNT	UNITS
PESTICIDES	2	4,4'-DDT	2200	ug/kg
	2	DIELDRIN	1100	ug/kg
METALS	2	BERYLLIUM	0.6	mg/kg
	6	BERYLLIUM	0.7	mg/kg
	10	BERYLLIUM	0.5	mg/kg

SB96-06 SOIL RESULTS				
	DEPTH (FT)	ANALYTE	AMOUNT	UNITS
VOLATILES	4	TETRACHLOROETHENE	380	ug/kg
METALS	4	BERYLLIUM	0.6	mg/kg
	6	BERYLLIUM	0.7	mg/kg
	8	BERYLLIUM	0.7	mg/kg

SB96-08 SOIL RESULTS				
	DEPTH (FT)	ANALYTE	AMOUNT	UNITS
PESTICIDES	2	ALPHA BHC	130	ug/kg
	2	BETA BHC	550	ug/kg
	2	CHLORDANE	19000	ug/kg
	2	4,4'-DDD	4300	ug/kg
	2	4,4'-DDE	2400	ug/kg
	2	4,4'-DDT	20000	ug/kg
	2	DIELDRIN	570	ug/kg
	10	DIELDRIN	87	ug/kg
METALS	2	BERYLLIUM	0.7	mg/kg
	6	BERYLLIUM	0.7	ug/kg
	10	BERYLLIUM	0.6	mg/kg

SB96-09 SOIL RESULTS				
	DEPTH (FT)	ANALYTE	AMOUNT	UNITS
METALS	2	BERYLLIUM	0.5	mg/kg
	6	BERYLLIUM	0.7	mg/kg
	10	BERYLLIUM	0.6	mg/kg

12" WATER MAIN
EASEMENT
SB96-5

MW-17
PIT
SB96-7

Mn -2

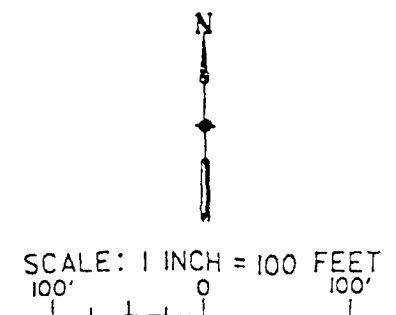
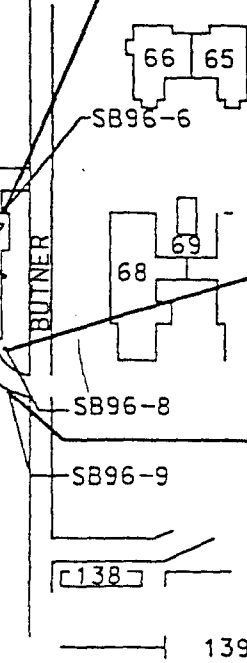
SB96-4

SB96-3

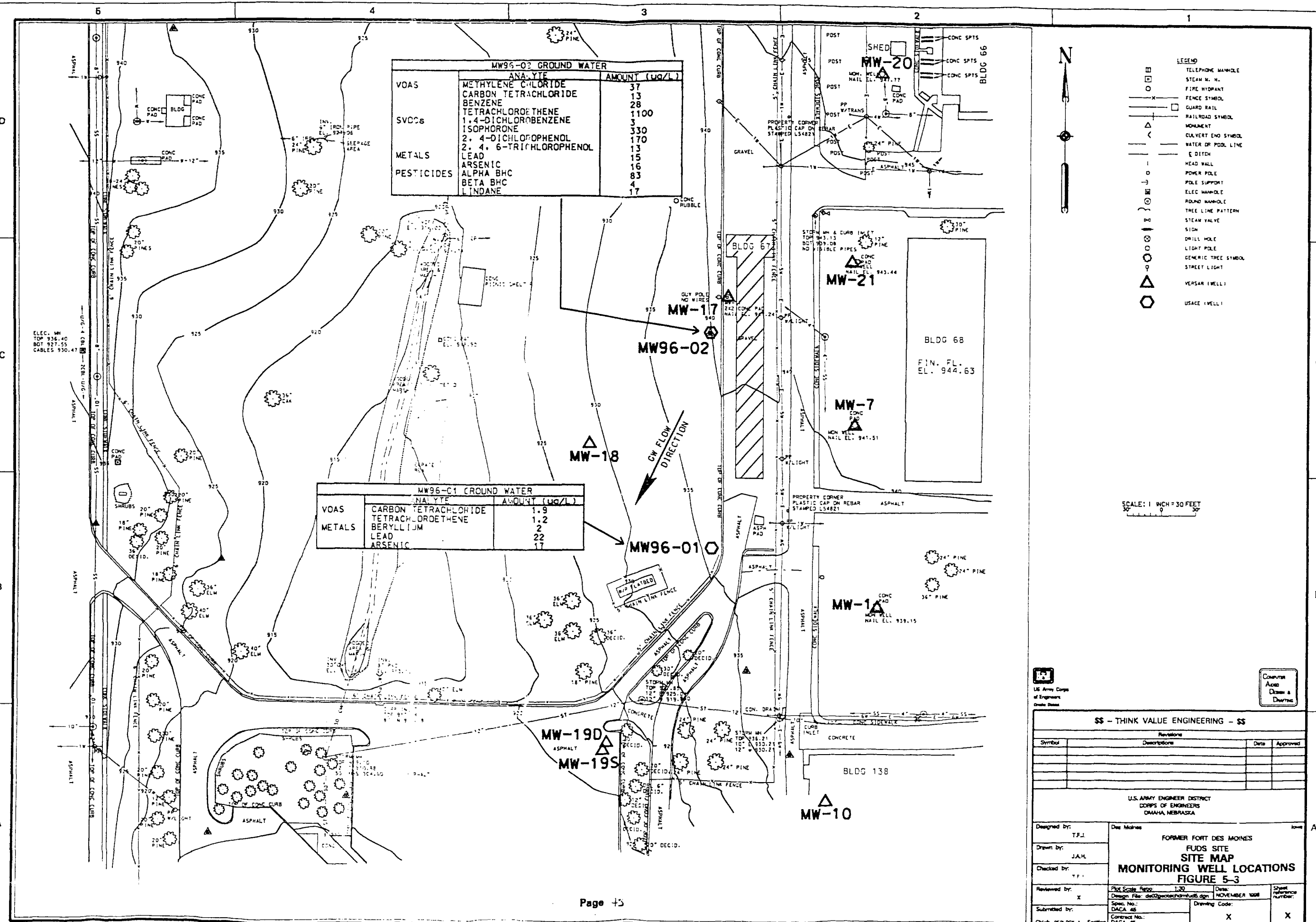
MW96-1

UNKNOWN SB

SW 9 TH STREET



FORT DES MOINES
DES MOINES, IOWA
FIGURE 5-2
ANALYTICAL SOIL RESULTS
BLOG. 67



5.1.1.5 Screening Criteria for Soil

No federally promulgated cleanup levels have been established for soil contamination. The contaminant concentrations detected in the soil found on this site will be compared to industrial risk-based levels from guidance published by the EPA Region III RBCs (industrial) and BTAG (Biological Technical Assistance Group) screening levels, since no guidance has been published by Region VII. Region VII is the EPA region where this site is located. Comparison to these RBCs will provide a conservative screening for soil contamination. This conservative approach is due to the assumptions made in the Region III risk calculations. The industrial calculations assume that there is always a worker working at that site for 8 hours/day for 250 days/year. The current site is used as a parking lot and is used every day in the summer. But, the exposure to soil does not occur for much of the year during the winter. For these reasons, the Region III RBCs are considered a conservative screening tool. EPA Region III BTAG screening levels are "based upon the lowest value from a combination of sources considered to be protective of the most sensitive organism in the media." Thus the screening levels are conservative and protective of ecological receptors.

The Region III industrial RBCs and EPA Region III BTAG screening levels provide "to be considered" (TBC) guidelines of potential risks associated with the site soil. "To be considered" guidance are non-promulgated advisories, proposed rules, criteria, or guidance documents issued by federal or state governments. These advisories and guidance are to be considered when determining protective cleanup levels where no promulgated regulations exist or where the promulgated regulations are not sufficiently protective of human health and the environment.

5.1.2 Groundwater

Groundwater samples were analyzed for VOCs, SVOCs, pesticides, and metals. The analytical results for groundwater indicated that various volatile organic compounds, semi-volatile organic compounds, pesticides and metals concentrations were elevated above either EPA Region III RBCs or IDNR MCLs. The samples that exceed EPA Region III RBCs or IDNR MCLs are provided in Table 5-2 and Figure 5-3.

5.1.2.1 Volatile Organic Compounds

The results of VOC analysis indicated the presence of benzene, tetrachloroethene, methylene chloride and carbon tetrachloride. Benzene was present in GW96-02 with concentration of 28 µg/L which exceeds the MCL of 5 µg/L. Tetrachloroethene (PCE) was present in GW96-01 and GW96-02 with concentrations of 1.2J µg/L to 1100 µg/L, respectively. It is assumed that the source of PCE was a waste product associated with pesticide mixing or laboratory vessel cleaning. However, it is not known whether the Army used PCE at Building 67, but perhaps it could have been used in the veterinary hospital. Methylene chloride was also detected but at very low concentrations and it was detected in the method blanks. Carbon tetrachloride was detected in GW96-01 and GW96-02 with concentrations of 1.9J µg/L to 13J µg/L, respectively. These concentrations either exceed the EPA Region III RBC for tap water of 0.16 µg/L or the IDNR MCL of 5.0 µg/L for carbon tetrachloride.

5.1.2.2 Semi-volatile Organic Compounds

The results of SVOC analysis indicated the presence of 1,4-Dichlorobenzene, Isophorone, 2,4-Dichlorophenol and 2,4,6-Trichlorophenol. These analytes were detected in GW96-02 only. The analyte 1,4-Dichlorobenzene was present in GW96-02 with a concentration of 3.0J $\mu\text{g/L}$ which exceeds the EPA Region III RBC (tap water) of 0.47 $\mu\text{g/L}$, but not the IDNR MCL of 75 $\mu\text{g/L}$. Isophorone was present in GW96-02 with a concentration of 330 $\mu\text{g/L}$ which is above the Region III RBC of 71 $\mu\text{g/L}$. 2,4-Dichlorophenol was detected in GW96-02 with a concentration of 170 $\mu\text{g/L}$ which exceeds the EPA Region III RBC (tap water) of 110 $\mu\text{g/L}$. The compound 2,4,6-Trichlorophenol was detected with a concentration of 13 $\mu\text{g/L}$ which exceeds the EPA Region III RBC (tap water) of 6.1 $\mu\text{g/L}$.

5.1.2.3 Pesticides

The results of pesticides analysis indicated the presence of Alpha BHC, Beta BHC, delta BHC, and Lindane. Alpha BHC was present in GW96-02 at a concentration of 83 $\mu\text{g/L}$ which exceeded the residential RBC of 0.011 $\mu\text{g/L}$. Beta BHC was present in GW96-02 at concentration of 4 $\mu\text{g/L}$ which exceeded the residential RBC of 0.037 $\mu\text{g/L}$. Delta BHC was detected at 5 ug/l. No RBC exists for this compound. Lindane was present in GW96-02 at concentration of 17 $\mu\text{g/L}$ which exceeded the residential RBC of 0.052 $\mu\text{g/L}$. Pesticides were not detected above the detection limits in GW06-01. These pesticides are believed to be associated with the bending and bagging operations that occurred at Building 67 during the time Barco used the building.

5.1.2.4 Metals

The results of metals analysis indicated the presence of arsenic, beryllium, chromium, copper, lead, nickel, selenium and zinc. However, only arsenic and lead were detected at concentrations that exceeded the EPA Region III RBCs for tap water. Arsenic was present in GW96-01 at concentration of 17 $\mu\text{g/L}$ which exceeded the RBC of 0.045 $\mu\text{g/L}$. Lead was present in GW96-01 at concentration of 22 $\mu\text{g/L}$ which exceeded the RBC action level and IA DNR action level of 15 $\mu\text{g/L}$. In GW06-02, lead was detected at 15 $\mu\text{g/L}$ and arsenic at 16 $\mu\text{g/L}$.

5.1.2.5 Herbicides

Herbicides were analyzed for but were not detected above the laboratory detection limits.

5.1.2.6 Screening Criteria for Groundwater

Pertinent environmental regulations for groundwater at this site are the Iowa Department of Natural Resources' (IDNR) Maximum Contaminant Levels (MCLs) and EPA Region III RBCs. The contaminant concentrations detected in the groundwater on-site were compared to the MCLs established by IA DNR in Chapter 41 of the Iowa Administrative Code. The concentrations were also compared to EPA Region III RBCs. The Region III RBCs are protective of human health only. The RBC concentrations are calculated to be at excess risk of 1×10^{-6} or a hazard index of 1. These are very conservative values and EPA has stated that an acceptable risk range is from 1×10^{-6} to 1×10^{-4} and an acceptable hazard index of 1.

TABLE 5-2 SUMMARY OF GROUNDWATER SAMPLE RESULTS (BUILDING 67)

Well	Analyte	Concentration, µg/l	EPA Region III RBC, Tap Water (µg/l)	IDNR MCL,(µg/l)
GW96-01	Carbon Tetrachloride	1.9J	0.16	5
	Tetrachloroethene	1.2J	0.36	5
	Chromium	255	55000	100
	Lead	22	15#	15#
	Arsenic	17	0.045	50
GW96-02	Methylene Chloride	37	4.1	None
	Chloroform	560	0.15	None
	Carbon Tetrachloride	13J	0.16	5
	Benzene	28	0.36	5
	Tetrachloroethene	1100	1.1	5
	1,4-Dichlorobenzene	3J	0.47	75
	Isophorone	330D	71	None
	2,4-Dichlorophenol	170	110	None
	2,4,6-Trichlorophenol	13	6.1	None
	Chromium	214	55000	100
	Lead	15	15#	15#
	Arsenic	16	0.045	50
	Alpha BHC	83	0.011	None
	Beta BHC	4	0.037	None
	Lindane	17	0.052	None
ug/l: micrograms per liter; parts per billion; ppb				
J: Estimated Concentration				
D: Derived from 1:4 dilution of extract				
#: lead value is an "action value" not Region III RBC				
none: no screening value exists for this compound				

5.2 ANALYTICAL RESULTS- OLD DUMP SITE

The following discussions will summarize analytical results by sample matrix. Soil sample results have been tabulated with a comparison to EPA Region III industrial RBCs (and Region III BTAG soil screening levels. In addition, EPA Region IV Eco Concern levels and ER-L/ER-M ranges were compared with the analytical results for sediment samples. Surface water analytical results have been tabulated with a comparison to EPA Region III RBCs and IDNR promulgated MCLs. Only the results that exceed either RBCs or MCLs are shown in the discussions in this section. The data presented in the following sections and the remaining bulk data is tabulated and provided as Appendix E.

5.2.1 Surface Soil

Soil samples were analyzed for volatile organics, semivolatile organics, pesticides and metals. The analytical results for surface (0-1') soils indicated that various semivolatile organics and beryllium were detected. Only arsenic concentrations were greater than EPA Region III BTAG soil screening levels. The samples that exceeded EPA Region III BTAG screening are provided in Table 5-1 and Figure 5-4.

5.2.2 Volatile Organic Compounds

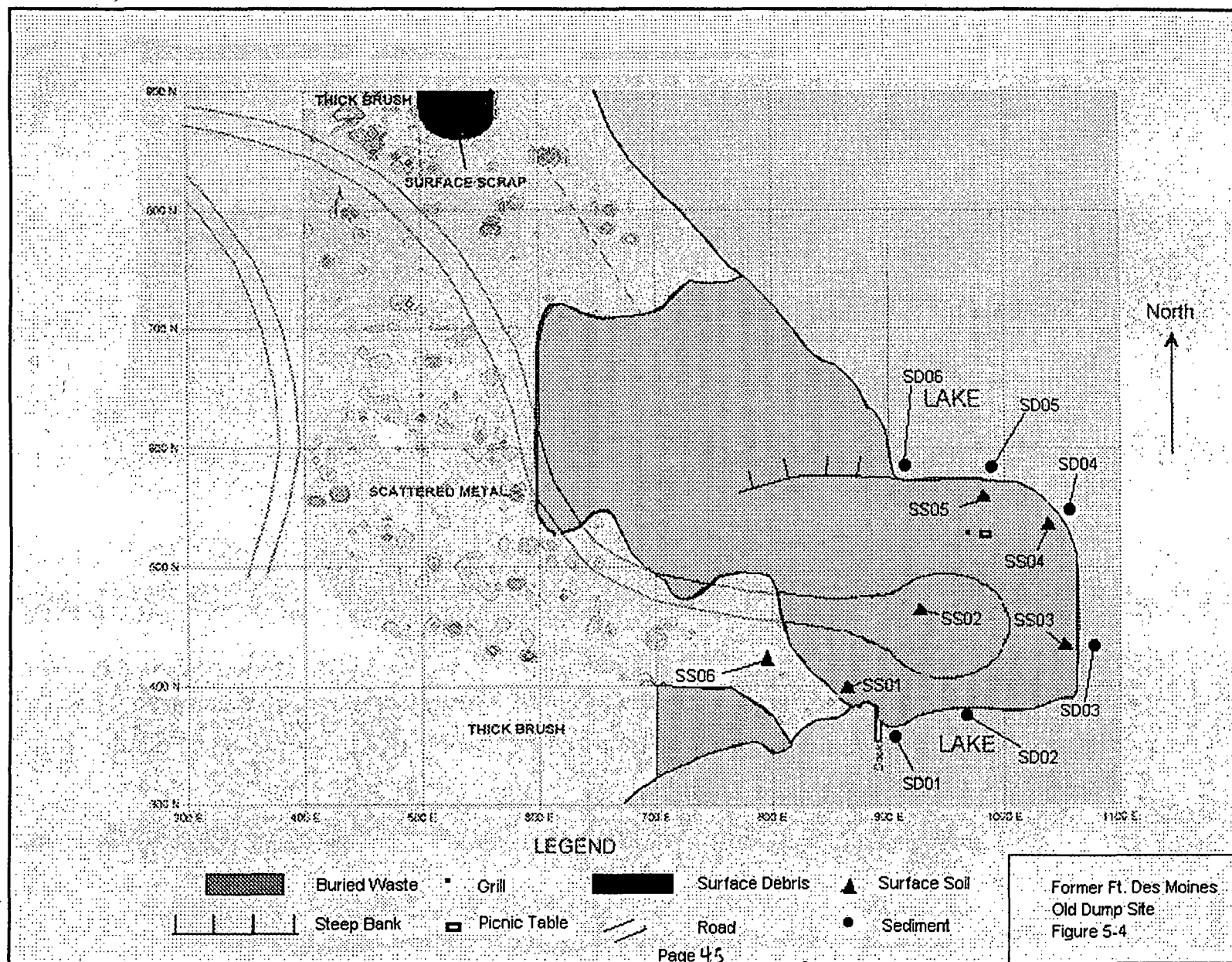
The results of VOC analysis indicated the presence of only methylene chloride. This compound was also detected in the associated method blank. Its presence in the sample is attributed to method blank contamination and it is not considered a contaminant of concern.

5.2.3 Semivolatile Organic Compounds

Several SVOCs were detected. They include phenol, naphthalene, 2-methylnaphthalene, acenaphthylene, acenaphthene, dibenzofuran, fluorene, phenanthrene, anthracene, di-n-butylphthalate, fluoranthene, pyrene, benzo(a)anthracene, chrysene, bis(2-ethylhexyl)phthalate, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, indeno (1,2,3-cd)pyrene, dibenz(a,h)anthracene, and benzo(g,h,i)perylene. However, none of these compounds were detected at concentrations above EPA Region III RBCs. The low level detections of the compounds may be attributed to naturally occurring sources.

5.2.4 Pesticides

The results of pesticides analysis indicated the presence of 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT in all six surface soil samples. However, none of the concentrations detected were over the industrial Region III RBCs. The low levels detected are indicative of background levels of pesticides from use of these chemicals to control insects.



5.2.4.1 Metals

The results of metals analysis indicated the presence of antimony, arsenic, beryllium and mercury over the screening criteria. Antimony was detected in two (SS96-02-01 and SS96-06-01) samples at low levels that were greater than the EPA Region III BTAG Screening level. Beryllium was detected at concentrations greater than the EPA Region III BTAG Soil Screening Level in all six soil samples (plus one duplicate). Sample SS96-01-01 had a beryllium concentration of 2.2 mg/kg. Duplicate samples SS96-06-01 and SS96-06-01-01 had concentrations of 2.6 and 2.2 mg/kg respectively. These are both over the BTAG Screening Level of 0.02 mg/kg. Beryllium was not detected at concentrations greater than the Region III RBC of 4100 mg/kg. Arsenic was detected over the EPA Region III RBC and EPA Region III BTAG soil screening values in all six soil samples (plus one duplicate). Mercury was detected over the EPA Region III BTAG soil screening value of 0.058 mg/kg in four samples. Mercury concentrations ranged from 0.16 mg/kg to 0.4 mg/kg.

5.2.5 Screening Criteria for Soil

No federally promulgated cleanup levels have been established for soil contamination. The contaminant concentrations detected in the soil found on this site will be compared to industrial risk-based levels from guidance published by the EPA Region III RBCs (industrial) and BTAG (Biological Technical Assistance Group) screening levels, since no guidance has been published by Region VII. Region VII is the EPA region where this site is located. Comparison to these RBCs and screening levels will provide a conservative screening for soil contamination. This conservative approach is due to the assumptions made in the Region III risk calculations. The industrial calculations assume that there is always a worker working at that site for 8 hours/day for 250 days/year. The current site is used as a recreational area and is used every day in the summer. But, the exposure to the soil does not occur for much of the year during the winter. For these reasons, the Region III RBCs are considered a screening tool and are considered health protective. Region III BTAG screening levels are "based upon the lowest value from a combination of sources considered to be protective of the most sensitive organism in the media." Thus the screening levels are conservative and protective of ecological receptors.

The EPA Region III RBCs and BTAG screening levels provide "to be considered" (TBC) guidelines of potential risks associated with the site soil. "To be considered" guidance are non-promulgated advisories, proposed rules, criteria, or guidance documents issued by federal or state governments. These advisories and guidance are to be considered when determining protective cleanup levels where no promulgated regulations exist or where the promulgated regulations are not sufficiently protective of human health and the environment.

TABLE 5-3 SUMMARY OF SURFACE SOIL SAMPLE RESULTS (OLD DUMP SITE)

Sample	Analyte	Amount in mg/kg	EPA Region III BTAG Soil Screening Levels (mg/kg)	EPA Region III RBCs, Industrial, Soil Ingestion (mg/kg)
SS96-01-01	Beryllium	2.2	0.02	4100
	Arsenic	8.2	0.328	3.8
	Mercury	0.16	0.058	None
SS96-02-01	Antimony	1.4 J	0.48	820
	Beryllium	0.7	0.02	4100
	Arsenic	10	0.328	3.8
	Mercury	0.17	0.058	None
SS96-01-03	Beryllium	0.7	0.02	4100
	Arsenic	5.9	0.328	3.8
	Mercury	0.4	0.058	None
SS96-01-04	Beryllium	0.06	0.02	4100
	Arsenic	7.1	0.328	3.8
SS96-01-05	Beryllium	0.6	0.02	4100
	Arsenic	6.9	0.328	3.8
SS96-01-06	Antimony	0.5	0.48	820
	Beryllium	2.6	0.02	4100
	Arsenic	9.5	0.328	3.8
	Mercury	0.26	0.058	None
SS96-01-06 (duplicate)	Beryllium	2.2	0.02	4100
	Arsenic	9.5	0.328	3.8
	Mercury	0.27	0.058	None

5.2.6 Sediment

Sediment samples were analyzed for volatile organics, semivolatile organics, pesticides and metals. The analytical results for the six sediment samples showed that various volatile organics, semivolatile organics, metals and pesticides were either elevated above NOAA ER-L or ER-M or EPA Region IV Eco Concern levels. The samples that exceed the screening criteria are illustrated on Table 5-4 and Figure 5-4.

5.2.6.1 Volatile Organic Compounds

The results of VOC analysis indicated the presence of acetone and methylene chloride. Methylene chloride was also detected in the associated method blank. Its presence in the sample is attributed to method blank contamination and it is not considered a contaminant of concern. The acetone concentration detected was an estimate concentration, detected lower than the laboratory's detection limit and is not of concern.

5.2.6.2 Semivolatile Organic Compounds

Several SVOCs were detected in one or more of the sediment samples. They include 4-methylphenol, naphthalene, 2-methyl naphthalene, hexachlorocyclopentadiene, 1,2,4-trichlorobenzene, 2,4,6-trichlorophenol, and acenaphthylene. 2-methylnaphthalene was detected above the ER-L of 70 ug/kg in sample SD96-01-01 at a concentration of 120J ug/kg. Sample SD96-03-01 contained 80J ug/kg of acenaphthylene which is above the ER-L of 44 ug/kg. However, all of the other semivolatiles detected were at estimated concentrations, detected lower than the laboratory's detection limit. The low level detections of all of the semivolatile compounds is attributed to naturally occurring sources.

5.2.6.3 Pesticides

The results of pesticides analysis indicated the presence of 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT in four sediment samples.

Sample SD096-01-01 contained 16 µg/kg 4,4'-DDE, 29 µg/kg 4,4'-DDT and 38 µg/kg dieldrin. All three compounds are detected over the ER-L value.

Sample SD96-03-01 contained several elevated concentrations of many pesticides. Alpha BHC, Beta BHC, Delta BHC, Lindane, chlordane, 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, and dieldrin were all detected in this sample. All detections were greater than the ER-L values.

Samples SD96-04-01 and SD96-06-01 both show low level detections of 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT. All values detected are greater than the ER-L value.

5.2.6.4 Metals

The results of metals analysis indicated the presence of cadmium, chromium, copper, lead, nickel, zinc, arsenic and mercury. Concentrations detected are over the ER-L value for all of these compounds. Ranges of metals and the ER-L are the following:

Cadmium	1.8 mg/kg in one sample	ER-L 1.2 mg/kg
Chromium	221 mg/kg in one sample	ER-L 81 mg/kg

Copper	42.5 to 143 mg/kg in 4 samples	ER-L 34 mg/kg
Lead	88 to 488 mg/kg in 6 samples	ER-L 46.7 mg/kg
Nickel	24.1 to 36.5 mg/kg in 6 samples	ER-L 20.9 mg/kg
Zinc	189 to 571 mg/kg in 7 samples	ER-L 150 mg/kg
Arsenic	9.1 to 23 mg/kg in 2 samples	ER-L 8.2 mg/kg
Mercury	0.13 to 0.39 in 3 samples	ER-L 0.15 mg/kg

5.2.7 Screening Criteria for Sediment

No federally promulgated cleanup levels have been established for sediment contamination. The sediment results were compared against National Oceanic and Atmospheric Administration (NOAA) ER-L and ER-M and Region IV Ecological Concerns Values. Both of these different screening values are for the protection of ecological receptors. There are currently no screening values for human health protection. NOAA has printed Effects Range -Low (ER-L) and Effects Range -Median (ER-M) values in sediment. These values represent the relative likelihood or potential for adverse biological effects occurring due to exposure of biota to toxicants in sediments. The ER-L and ER-M values were established objectively by determining the lower 10 and 50 percentiles in data gathered by NOAA. Although the consensus ER-L and ER-M concentrations may be used as guidance in evaluating sediment contamination data, there is no intent expressed or implied that these values represent official NOAA standards. The Region IV Ecological Screening Values are based on contaminant levels associated with a low probability of unacceptable risks to ecological receptors. These values are based on conservative endpoints and sensitive ecological effects data. For these reasons, comparison to these values will provide a conservative screening for sediment contamination. The ER-L and ER-M values provide "to be considered" (TBC) guidelines of potential risks associated with the site sediment. "To be considered" guidance are non-promulgated advisories, proposed rules, criteria, or guidance documents issued by federal or state governments. These advisories and guidance are to be considered when determining protective cleanup levels where no promulgated regulations exist or where the promulgated regulations are not sufficiently protective of human health and the environment.

TABLE 5-4 SUMMARY OF SEDIMENT SAMPLE RESULTS (OLD DUMP SITE)

Sample	Analyte	Concentration , µg/kg**	ER-L/ER-M, µg/kg **	Region 4 Eco Concerns, µg/kg**
SD96-01-01	2-methylnaphthalene	120J	70/670	330
	4,4'-DDE	16	2.2/27	3.3
	4,4'-DDT	29	1.58/46.1	3.3
	dieldrin	38	0.02/8	3.3
	cadmium	1.8	1.2/9.6	1
	copper	51.5	34/270	18.7
	lead	216	46.7/218	30.2
	nickel	31	20.9/51.6	15.9
	zinc	371	150/410	124
	Mercury	0.13	0.15/0.71	0.13
	arsenic	23	8.2	70
SD96-02-01	lead	88	46.7/218	30.2
	Copper	31	34/270	18.7
	nickel	24.1	20.9/51.6	15.9
	zinc	189	150/41.0	124
SD96-02-01-01(duplicate of 02-01)	copper	42.5	34/270	18.7
	lead	128	46.7/218	30.2
	nickel	28.9	20.9/51.6	15.9
	zinc	196	150/410	124
	mercury	0.15	0.15/0.71	0.13
SD96-03-01	acenaphthylene	80J	44/640	330
	alpha-BHC	810J		
	beta-BHC	980		
	delta-BHC	250		
	lindane	420		3.3
	chlordane	22000	0.5/6	1.7
	4,4'-DDD	15000	3/350	3.3
	4,4'-DDE	7400	2.2/27	3.3
	4,4'-DDT	50000	1.58/46.1	3.3
	dieldrin	2500	0.02/8	3.3
	Copper	26	34/270	18.7
	lead	142	46.7/218	30.2
	nickel	24.6	20.9/51.6	15.9
	zinc	268	150/410	124
	arsenic	9.1	8.2/70	7.24
	mercury	0.39	0.15/0.71	0.13
SD96-04-01	4,4'-DDD	51	3/350	3.3
	4,4'-DDE	78	2.2/27	3.3
	4,4'-DDT	36	1.58/46.1	3.3
	Cadmium	1.9	1.2/9.6	1
	copper	46.2	34/270	18.7

SD96-04-01	lead	488	46.7/218	30.2
	nickel	29.2	20.9/51.6	15.9
	zinc	241	150/410	124
SD96-05-01	copper	21.9	34/270	18.7
	Lead	3.3	46.7/218	30.2
	zinc	203	150/410	124
SD96-06-01	4,4'-DDD	70	3/350	3.3
	4,4'-DDE	54	2.2/27	3.3
	4,4'-DDT	45	1.58/46.1	3.3
	Cadmium	1.8	1.2/9.6	1
	chromium	221	81/370	52.3
	copper	143	34.270	18.7
	lead	409	46.7/218	30.2
	nickel	36.5	20.9/51.6	15.9
	zinc	571	150/410	124
ug/kg micrograms per kilogram; parts per billion; ppb				
**: Units for inorganics are in mg/kg, milligrams per kilogram, parts per million				
J: Estimated Concentration				
ER-L: Effects Range, Low ER-M: Effects Range, Median				

5.2.8 Surface Water

One surface water sample was taken and analyzed for volatile organics, semivolatile organics, pesticides and metals. The analytical results showed only one estimated concentration of bis(2-ethylhexyl)phthalate at 1 JB $\mu\text{g/l}$ and arsenic at 3 $\mu\text{g/l}$. Bis(2-ethylhexyl)phthalate is a common laboratory contaminant and was also found in a blank. It appears that Bis(2-ethylhexyl)phthalate is not present in the surface water. The EPA Region IV Chronic Freshwater Quality Screening value for arsenic is 190 $\mu\text{g/l}$. These detections are very low level and indicate that the surface water has not been contaminated by past dumping activities. In one sample, arsenic exceeded the EPA Region III tap water RBC of 0.045 ug/l but not the Iowa MCL of 50 ug/l . No other contaminants were detected in the surface water.

5.2.9 Screening Criteria for Surface Water

No promulgated cleanup levels have been established for surface water contamination. The contaminant concentrations detected in the surface water found on this site were compared to EPA Region IV Chronic Freshwater Quality Screening Values, which are protective of ecological receptors.. There is currently no guidance that has been published by Region VII. Region VII is the EPA region where this site is located. There are currently no screening values for human health protection. The ecological screening values are based on contaminant levels associated with a low probability of unacceptable risks to ecological receptors. These values are based on conservative endpoints and sensitive ecological effects data. For these reasons, comparison to EPA Region IV Chronic Freshwater Quality Screening Values will provide a conservative screening for surface water contamination.

The EPA Region IV Chronic Freshwater Quality Screening Values provide “to be considered” (TBC) guidelines of potential risks associated with the site surface water. “To be considered” guidance include non-promulgated advisories, proposed rules, criteria, or guidance documents issued by federal or state governments. These advisories and guidance are to be considered when determining protective cleanup levels where no promulgated regulations exist or where the promulgated regulations are not sufficiently protective of human health and the environment.

5.3 EVALUATION OF DATA QUALITY

The laboratory analytical data was reviewed and verified by the government and contract laboratories (MR Laboratory and Continental Analytical Services) and evaluated by the USACE project chemist for compliance with project objectives. Data usability was determined by comparing the project DQOs against the quality of the final analytical results. The analytical program for this project conformed with the USACE-Omaha District Chemistry General SOS and the General Geology SOS. Samples were also collected and analyzed in accordance with ASTM and EPA, and using laboratory specific QA/QC procedures. These procedures were followed to generate high quality data.

5.3.1 USACE Project Chemist Data Quality Evaluation

In addition to the internal validation conducted by MR Lab and CAS, the USACE project chemist performed data validation of the data set. This included an evaluation and validation of samples based on:

- Field Duplicate Analyses
- Trip blank analyses
- Initial sample inspection and COC documentation;
- Holding Times;
- Duplicate Control Samples;
- Method Blank Analyses
- Surrogate recoveries;
- The precision, accuracy, representativeness, completeness, and comparability (PARCC) parameters as they apply to this CDQAR; and
- An overall assessment of data compared to the project DQOs.

A more complete description of the data quality evaluation that was performed can be found in the Chemical Data Quality Assessment Report (CDQAR) dated May 29, 1997, which is included as Appendix F.

The data quality evaluation found that there were some instances of out-of-control quality control by the analytical laboratory. These instances and their impact on the data are described below.

5.3.1.1 Former Building 67 - Deficiencies and Corrective Action

Several of the out of control QC issues impact the usability of the data. Removing false negatives and positives from the data set provides a more accurate portrayal of conditions existing at the Former Building 67 and Old Dump Site and complies with the corrective action DQO goal for the project. The reviewed and qualified data are suitable for addressing the overall objective of this investigation: to evaluate the nature and vertical and lateral extent of contamination associated with these two sites. In addition, the collected data can be used to evaluate risk to human health and the environment and to make risk-based recommendations regarding whether or not further investigation or remediation is warranted.

5.3.1.2 Old Dump Site - Deficiencies and Corrective Action

Sample ODS-SS96-01-01 was analyzed as part of analytical Batch 080694A for pesticides. The MS and the MSD recovery were both negative for this sample. This resulted in qualification of 4,4'-DDT for this sample as "R", rejected. Since there was only one sample in the analytical batch, no other samples required qualification. The laboratory detected 94 ug/kg 4,4'-DDT in sample ODS-SS96-01-01. However, since this was qualified as "R", this data point is unusable. The significance of this should not be severe, since the concentration was lower than the EPA Region 3 RBC for DDT.

For SVOC Batch 960822es2, three of the MSD spiking compounds (1,4-dichlorobenzene, 1,2,4-trichlorobenzene, and pentachlorophenol) and one (pentachlorophenol) of the MS spiking compounds had percent recoveries lower than the laboratory control limits. This batch also experienced LCS difficulties. Professional judgment was used in qualification based on MS and MSDs. Only one of these spiking compounds was detected in a sample analysis. 1,2,4-trichlorobenzene was detected in sample ODS-SD96-03-01 at 290 ug/kg. This detect has been qualified as "R" and is not usable. This should be insignificant since the concentration detected

was lower than the EPA Region III RBC for 1,2,4-trichlorobenzene. All other samples in the batch were nondetect and have been qualified as "RU".

A total of seventeen LCS percent recoveries were outside of the laboratory control limits. The seventeen recoveries were contained in three different analytical batches. The three effected batches were: Batch 960822es2, SVOCs; Batch 092096A, Pesticides; and Batch 960827ew2, SVOCs. Data usability was affected for only two semivolatile compounds, 1,3-dichlorobenzene and 1,2-dichlorobenzene, in one batch (960822es2). There were no detections of these two compounds in the analytical batch. All non-detects have been qualified "RU". No other data has been rejected based on the LCS results.

6 CONCLUSIONS AND RECOMMENDATIONS

The United States Army Corps of Engineers conducted a site investigation at the former Ft. Des Moines Building 67 and Old Dump sites. The investigation consisted of collecting soil, sediment, surface water and ground water samples and analyzing them for various compounds of concern.

6.1 BUILDING 67 CONCLUSIONS

6.1.1 General

Former Building 67 was formerly utilized as a pesticide mixing facility by a private corporation, Barco Chemical Company, during the years 1950 to 1959. Barco Chemical Company conducted the pesticide mixing operation in both Buildings 67 and 138, under a lease agreement with DoD. The building was demolished in 1961. The ownership of the property that was once occupied by Building 67 was transferred to the City of Des Moines.

An Interim Remedial Action was performed by USACE, Rapid Response Section in 1995. This IRA consisted of the removal of a pesticides contaminated drain conduit and adjacent soil that previously existed between Building 67 and Building 138. This IRA was conducted on the BRAC portion of the site only. A chain link fence exist between the BRAC site (Building 138) and the FUDS (Building 67). The FUDS portion of the drain conduit and associated contaminated soil was not removed because of regulatory, contracting and budgetary constraints. Since the investigation of Building 138 was performed under a BRAC contract, the appropriation that funded this investigation did not allow contracting an IRA for FUDS. As a result, the conduit and contaminated soil on the FUDS portion of the overall site was not removed during the IRA. This report is intended to ascertain whether further remedial actions are required.

6.1.2 Soil

The contamination encountered at the Building 67 site primarily consisted of pesticides in soil. The most significant exceedances encountered at the former Building 67 site were the elevated pesticide levels for chlordane, dieldrin, 4,4'-DDD, 4,4'-DDE and 4,4'-DDT that were detected in soil samples from borings SB96-1, SB96-5, SB96-7 and SB96-8. Two borings, SB96-5 and SB96-8, appear to be in or very near the source(s) of the pesticides release. It is probable that the pesticides detected in SB96-8 result from its close proximity to the drain conduit that was left in place after the BRAC removal action. It is assumed that the results from SB96-05 indicate that this boring was located close to an interior floor drain or drain conduit. The vertical distribution of pesticide impacted soil indicated relatively shallow impacts in SB96-8 (2-4 ft. b.g.s.) and relatively deep impacts in SB96-05 (2-10 ft. b.g.s.). The magnitude of pesticides impacts to soil in both borings decreased with depth dramatically. It is also possible that elevated Pesticides concentrations at the deeper sample intervals in SB96-05 may have been carried down during the drilling process. With these two exceptions, the remaining pesticides impacted soils do not appear to represent a significant risk to human health or the environment. Beryllium concentrations exceeded EPA Region III BTAG soil screening levels but not Region III RBC's. Copper, Chromium, Lead, Nickel and Zinc concentrations in most surface and subsurface soil samples exceeded the EPA Region III BTAG screening levels. All of the metals discussed above however, did not exceed 2 times the background concentrations for these metals as calculated by Versar (EI/RA/AA, 1995).

6.1.3 Groundwater

The contamination encountered at the Building 67 site primarily consisted of VOCs, SVOCs and pesticides in groundwater. It was noted that lead and arsenic were detected at levels that slightly exceeded IDNR promulgated MCLs in groundwater. The lead and arsenic detected in groundwater is also likely to have resulted from suspended sediments that were present in the water samples. Tetrachloroethene (PCE) was detected in both soil and groundwater although the PCE concentrations in soil did not exceed screening levels. The PCE detected in groundwater exceeded both the EPA Region III RBC (tap water) and IDNR MCL in MW96-02. However, only the EPA Region III RBC (tap water) was exceeded in MW96-1. In groundwater samples, three pesticides, Alpha BHC, Beta BHC and Lindane, were detected at concentrations that exceeded the EPA Region III RBCs (tap water). In addition, the groundwater sample collected in MW96-02 indicated elevated concentrations of four semi-volatiles; 1,4-Dichlorobenzene, Isophorone, 2,4-Dichlorophenol and 2,4,6-Trichlorophenol, above their respective EPA Region III RBCs (tap water).

6.2 BUILDING 67 RECOMMENDATIONS

6.2.1 Soil

The recommendation for pesticides impacted soil includes the development of an EE/CA for removal of contaminated soil. The number and distribution of soil samples collected as part of this PA/SI are considered to be adequate for calculating soil volumes in support of a removal action, which is the anticipated future direction at this site. No further action is proposed for elevated metals concentrations because they appear to occur naturally.

6.2.2 Groundwater

The recommendation for VOC, pesticide and SVOC impacted groundwater includes the development of an EE/CA to evaluate removal actions for contaminated groundwater.

The metals and pesticides detected in groundwater at this site were only marginally elevated above their respective screening levels and they lack transport mobility. The metals detected in these groundwater samples were also detected in the soil samples collected at this site and are likely to be representative of background concentrations. The surficial aquifer flow conditions are not conducive to groundwater flow that would be suitable for a private, municipal or industrial water supply. The only potential threat to down-gradient water supplies would be off-site migration of impacted groundwater via seepage into the creek channel down-gradient from the site. Based on the low hydraulic conductivity encountered at this site it is highly unlikely that contaminant transport off site is occurring or will occur in the near future. For these reasons, it is not currently recommended that contaminated groundwater be removed solely to remediate metals or pesticides impacted groundwater.

6.3 OLD DUMP SITE CONCLUSIONS

A total of six surface soil, six sediment and one surface water sample was collected at the Old Dump Site. Of these samples the data collected from six sediment and six surface soil samples exceeded the selected screening criteria. Various analytes of concern were detected at

concentrations that exceeded either the EPA Region IV Eco Concerns or NOAA's ER-L/ER-M guidance. It should be noted that these guidelines are not promulgated action levels but rather a means of screening data for a comparative baseline. These guidance levels do not take into account regional or locally elevated concentrations of metals that may be entirely natural in origin. It is obvious that any pesticides detected occur directly as a result of anthropogenic activity, such as pest control.

The Iowa Department of Natural Resources (IDNR) Fisheries Management Division sampled fish for potential chemical contamination in 1995. Bioassay results documented that largemouth bass tissue samples indicated elevated concentrations of DDE (0.073 mg/kg) and Methoxychlor (0.22 mg/kg) only. All other analytes were below quantitation limits. The elevated DDE concentration detected in the fish tissue sample compared to lake sediment samples illustrating the effect of bioaccumulation of this contaminant on a predator species which is incidentally exposed to suspended sediments during windy conditions and by consumption of prey with potentially greater exposure. The Iowa Department of Natural Resources (IDNR) issued a letter report to USACE, Omaha District, in which the Fisheries Management personnel determined that the levels of contamination were not believed to present an immediate or long-term health risk to human receptors.

6.3.1 Sediment

The primary analytes of concern that were detected in sediment samples at the Old Dump site were pesticides, metals and SVOCs. The pesticides, alpha BHC, beta BHC, delta BHC, lindane, chlordane, dieldrin, 4,4'-DDT, 4,4'-DDD and 4,4'-DDE were detected in some sediments that exceeded the selected screening criteria.

The metals arsenic, cadmium, chromium, copper, lead, nickel, mercury and zinc were detected in sediment samples exceeding the selected ecological screening criteria.

The semi-volatiles, 2-methylnaphthalene and acenaphthalene, were detected at concentrations that exceeded the selected screening criteria. The presence of these semi-volatiles in sediment is inconclusive because they were detected at concentrations below their respective reporting limits and thus are estimates.

6.3.2 Soil

The metals beryllium, arsenic, antimony and mercury were detected in surface soils in concentrations that exceeded the selected EPA Region III screening criteria.

6.3.3 Surface Water

Bis(2-ethylhexyl)phthalate and arsenic were detected in the surface water sample. Bis(20ethylhexyl)phthalate is attributed to laboratory contamination. The concentration of arsenic in the surface water sample was less than EPA Region IV Chronic Freshwater Quality screening levels for ecological receptors.

6.4 OLD DUMP SITE RECOMMENDATIONS

6.4.1 Sediment

Based on the current site use as a park, level of contamination and limited exposure pathway, the recommendation for pesticides in sediments at this site is No Further Action.

The presence of these metals in the sediment data is inconclusive as to whether they are actual contamination or naturally occurring. Comparison of the sampled concentrations of these metals with background concentrations suggests that it is probable that these metals occur in sediments at this site naturally. It should also be noted that the human exposure pathways are limited for metals impacted sediments at this site because the sediments are covered by a lake. However, the collection of a bioassay sample(s) (fish) from the reservoir at this site may be warranted to determine whether ecological receptors and human receptors may be adversely impacted by elevated metals in sediment.

The presence of SVOCs in sediment may not be related to past disposal activities since these two analytes are commonly found in diesel fuel and asphalt. Since the semi-volatiles were detected in sediments at relatively low estimated concentrations, No Further Action is recommended for semi-volatiles at this site.

6.4.2 Surface Soil

Beryllium, arsenic, antimony and mercury were detected over screening criteria. The levels of beryllium and mercury are low and the presence of these metals in the surface soil data is inconclusive as to whether it is actual contamination or naturally occurring. It is probable that these metals are naturally occurring in surface soils at this site, based on a comparison with published background concentrations depicted in Section 4. Arsenic levels are less than published background concentrations and site specific background concentrations discussed in Section 4. The magnitude of antimony concentration detected in surface soil is generally low with respect to background and not of concern. No Further Action is recommended for metals at this site.

6.4.3 Surface Water

The results for the analyses of surface water indicated that the detection of bis(2-ethylhexyl)phthalate and arsenic are not of concern. No Further Action is recommended for surface water at this site.

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APPENDIX A

BORING LOGS

HTRW DRILLING LOG				DISTRICT MRO		HOLE NUMBER SB/MW96-1	
1. COMPANY NAME USACE				2. DRILL SUBCONTRACTOR CEMROEDGG		SHEET 1 OF 4 SHEETS	
3. PROJECT FT. DES MOINES BLDG. 67				4. LOCATION DES MOINES, IA.			
5. NAME OF DRILLER AL OAKS				6. MANUFACTURER'S DESIGNATION OF DRILL GUS PECH 1100C			
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT				8. HOLE LOCATION SEE BELOW			
4 1/4" ID HSA. BULLET BIT. 3" OD SPLIT SPOON (STAINLESS STEEL)				9. SURFACE ELEVATION			
				10. DATE STARTED 07-22-96		11. DATE COMPLETED 07-22-96	
12. OVERBURDEN THICKNESS -				15. DEPTH GROUNDWATER ENCOUNTERED 19.2' FT.			
13. DEPTH DRILLED INTO ROCK 0				16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED 13.5' FT. 1 HOUR			
14. TOTAL DEPTH OF HOLE 22.0' FT.				17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)			
18. GEOTECHNICAL SAMPLES		DISTURBED 1		UNDISTURBED 0		19. TOTAL NUMBER OF CORE BOXES -	
20. SAMPLES FOR CHEMICAL ANALYSIS		VOC 6 x 4oz		PP METALS Pest 3 x 8oz		OTHER (SPECIFY) Herb 3x8oz	
22. DISPOSITION OF HOLE		BACKFILLED -		MONITORING WELL 07-22-96		OTHER (SPECIFY) -	
						23. SIGNATURE OF INSPECTOR CAROLYN SCHWAFEL	
LOCATION SKETCH/COMMENTS				ALL MEASUREMENTS FROM THE CURB ARE TAKEN FROM GRASS SIDE		SCALE 1" = 20'	
<div style="text-align: center;"> <p>N ↑</p> </div>							
PROJECT FT. DES MOINES BLDG. 67						HOLE NO. SB/MW96-1	

HTRW DRILLING LOG (CONTINUATION SHEET)

HOLE NUMBER
SB/MW96-1

PROJECT FT. DES MOINES BLDG. 67

INSPECTOR CAROLYN SCHWAFEL

SHEET 2 OF 4 SHEETS

ELEV. (a)	DEPTH (b)	DESCRIPTION OF MATERIALS (c)	FIELD SCREENING RESULTS (d)	GEOTECH SAMPLE OR CORE BOX NO. (e)	ANALYTICAL SAMPLE NO. (f)	BLOW COUNT (g)	REMARKS (h)
		GRASS AND TOPSOIL	CALIBRATED HNU WITH 100 PPM ISOBUTYLENE @ 240 PSI			6	3" OD SPLIT SPOON 7-22-96 START 0834 STOP 0836
	1	CL-CH LEAN TO FAT CLAY WITH SILT, STIFF, LOW TO MEDIUM PLASTICITY, DRY, DARK BROWN			B67-SB 96-0102 2x4oz 2x8oz	5	
						7	N (BLOWS) = 12 REC. (RECOVERY) = 1.2'
			HEADSPACE <1			11	
	2	CL-CH LEAN TO FAT CLAY WITH SILT, SAME AS ABOVE				6	START 0840 STOP 0842
						8	
	3		HEADSPACE <1			10	N = 18 REC. = 1.0'
						13	
	4	CL-CH LEAN TO FAT CLAY, VERY STIFF, MEDIUM TO HIGH PLASTICITY, DRY, TRACE OF SILT, MEDIUM BROWN AND GRAY			B67-SB 96-0106 2x4oz 2x8oz	4	START = 0846 STOP = 0847
						7	
	5		HEADSPACE <1			9	N = 16 REC. = 1.4'
						10	
	6	CL-CH LEAN TO FAT CLAY SAME AS ABOVE EXCEPT MEDIUM STIFF				3	START 0901 STOP 0901
						3	
	7		HEADSPACE <1			4	N = 7 REC. = 1.9'
						5	
	8	CL-CH LEAN TO FAT CLAY MEDIUM STIFF, MEDIUM TO HIGH PLASTICITY, MOIST, STICKY, MEDIUM BROWN WITH RUST STAINING AND BLACK				2	START 0909 STOP 0910
						2	
	9		HEADSPACE <1		B67-SB 96-0110 2x4oz 2x8oz	3	N = 5 REC. = 2.0'
						4	
	10						

PROJECT FT. DES MOINES BLDG. 67

HOLE NO. SB/MW96-1

HTRW DRILLING LOG (CONTINUATION SHEET)							HOLE NUMBER SB/MW96-1
PROJECT FT. DES MOINES BLDG. 67		INSPECTOR CAROLYN SCHWAFEL				SHEET 3 OF 4 SHEETS	
ELEV. (a)	DEPTH (b)	DESCRIPTION OF MATERIALS (c)	FIELD SCREENING RESULTS (d)	GEOTECH SAMPLE OR CORE BOX NO. (e)	ANALYTICAL SAMPLE NO. (f)	BLOW COUNT (g)	REMARKS (h)
	11	CL-CH LEAN TO FAT CLAY. MEDIUM STIFF. MEDIUM TO HIGH PLASTICITY. MOIST. STICKY. MEDIUM BROWN WITH IRON STAINING	HEADSPACE N/A			2	START 0915 STOP 0915
						2	
						3	N = 5 REC. = 2.0'
						4	
	12	CL-CH LEAN TO FAT CLAY. MEDIUM STIFF. MEDIUM TO HIGH PLASTICITY. GRAY AND TAN WITH IRON STAINING STICKY. MOIST	HEADSPACE N/A			3	START 0932 STOP 0932
						3	
	13		HEADSPACE N/A			5	N = 8 REC. = 2.0'
		CL-CH HEAVILY OXIZED				7	
	14	CL-CH LEAN TO FAT CLAY WITH SAND. STIFF. HIGH PLASTICITY. DRY. LESS STICKY. DARK BROWN	HEADSPACE N/A			3	START 0937 STOP 0937
						4	
	15		HEADSPACE N/A			5	N = 9 REC. = 2.0'
		CL-CH LEAN TO FAT CLAY STIFF. MEDIUM TO HIGH PLASTICITY. STICKY. MOIST. BROWN WITH IRON STAINING	HEADSPACE N/A			7	
	16					3	START 0954 STOP 0955
						6	
7-22-96	17		HEADSPACE N/A			9	N = 15 REC. = 2.0'
1035						12	WATER ENCOUNTERED
1029	18	ML - LEAN SILT WITH TRACE OF GRAVEL. STIFF. LOW PLASTICITY. SOME FINE SAND AND GRAVEL. MOIST. GRAY WITH RUST STAINING	HEADSPACE N/A	19.0		3	START 1001 STOP
						5	
1021	19		HEADSPACE N/A	D-1		9	N = 14 REC. = 2.0'
						13	
	20			20.0			

HTRW DRILLING LOG (CONTINUATION SHEET)							HOLE NUMBER SB/MW96-1
PROJECT FT. DES MOINES BLDG. 67		INSPECTOR CAROLYN SCHWAFEL				SHEET 4 OF 4	
ELEV. (a)	DEPTH (b)	DESCRIPTION OF MATERIALS (c)	FIELD SCREENING RESULTS (d)	GEOTECH SAMPLE OR CORE BOX NO. (e)	ANALYTICAL SAMPLE NO. (f)	BLOW COUNT (g)	REMARKS (h)
	21	ML - LEAN SILT WITH SAND AND GRAVEL, VERY STIFF, LOW PLASTICITY, FINE SAND AND GRAVEL, GRAY WITH RUST STAINING, WET				5	START 1018 STOP 1019
						9	
						16	N = 25 REC. = 2.0'
	22	BOTTOM OF HOLE = 22.0'				21	
	23						MONITORING WELL INSTALLED ON 7-22-96 (SEE WELL DIAGRAM)
	24						

PROJECT FT. DES MOINES BLDG. 67

HOLE NO. SB/MW96-1

HTRW DRILLING LOG				DISTRICT MRO		HOLE NUMBER SB/MW96-2	
1. COMPANY NAME USACE				2. DRILL SUBCONTRACTOR CEMROEDGG		SHEET 1 OF 5	
3. PROJECT FT. DES MOINES BLDG. 67				4. LOCATION DES MOINES, IA.			
5. NAME OF DRILLER AL OAKS				6. MANUFACTURER'S DESIGNATION OF DRILL GUS PECH 1100C			
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT 4 1/4" ID HSA. BULLET BIT. 3" OD SPLIT SPOON (STAINLESS STEEL)				8. HOLE LOCATION SEE BELOW			
				9. SURFACE ELEVATION			
				10. DATE STARTED 07-18-96		11. DATE COMPLETED 07-19-96	
12. OVERBURDEN THICKNESS -				15. DEPTH GROUNDWATER ENCOUNTERED 17.9' FT.			
13. DEPTH DRILLED INTO ROCK 0				16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED 12.45' FT. 18 HOUR			
14. TOTAL DEPTH OF HOLE 31.5' FT.				17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)			
18. GEOTECHNICAL SAMPLES		DISTURBED 1		UNDISTURBED 0		19. TOTAL NUMBER OF CORE BOXES -	
20. SAMPLES FOR CHEMICAL ANALYSIS		VOC 8 x 4oz		PP METALS Pest 4 x 8oz	OTHER (SPECIFY) Herb 4x8oz	OTHER (SPECIFY) -	OTHER (SPECIFY) -
22. DISPOSITION OF HOLE		BACKFILLED -		MONITORING WELL 07-19-96	OTHER (SPECIFY) -	23. SIGNATURE OF INSPECTOR CAROLYN SCHWAFEL	
21. TOTAL CORE RECOVERY %							
LOCATION SKETCH/COMMENTS				ALL MEASUREMENTS FROM THE CURB ARE TAKEN FROM GRASS SIDE		SCALE 1" = 20'	
<div style="display: flex; justify-content: space-between; align-items: flex-start;"> <div style="text-align: center;"> <p>N</p> <p>↑</p> </div> <div style="text-align: center;"> <p>EXISTING ⊗ MW-17 5.5'</p> <p>CURB</p> <p>10'</p> <p>32.5'</p> <p>⊗ MW96-2</p> <p>GRASS</p> </div> <div style="text-align: center;"> <p>BLANK PARK</p> <p>GRAVEL PARKING AREA (FORMER BLDG. 67)</p> </div> </div>							
PROJECT FT. DES MOINES BLDG. 67						HOLE NO. SB/MW96-2	

HTRW DRILLING LOG (CONTINUATION SHEET)							HOLE NUMBER SB/MW96-2
PROJECT FT. DES MOINES BLDG. 67			INSPECTOR CAROLYN SCHWAFEL			SHEET 2 OF 5	
ELEV. (a)	DEPTH (b)	DESCRIPTION OF MATERIALS (c)	FIELD SCREENING RESULTS (d)	GEOTECH SAMPLE OR CORE BOX NO. (e)	ANALYTICAL SAMPLE NO. (f)	BLOW COUNT (g)	REMARKS (h)
	1	GRASS AND TOPSOIL CL - SILTY LEAN CLAY WITH GRAVEL. LOW - MEDIUM PLASTICITY. VERY STIFF. MOIST MEDIUM BROWN. ANGULAR. FINE GRAVEL	CALIBRATED HNU WITH 100 PPM ISOBUTYLENE @ 240 PSI			8	3" OD SPLIT SPOON 7-18-96 START 1056 STOP 1057
						13	
						15	N (BLOWS) = 28 REC. (RECOVERY) = 0.3'
			HEADSPACE 0			10	NOT ENOUGH FOR SAMPLE
	2						
	3	CL-CH LEAN TO FAT CLAY WITH SILT. MEDIUM TO HIGH PLASTICITY. VERY STIFF. MOIST. TRACE OF GRAVEL. MEDIUM BROWN WITH IRON STAINING			B67-SB 96-0201 2x4oz 2x8oz	6	START 1103 STOP 1104
			HEADSPACE 0			9	
						11	N = 20 REC. = 1.1'
						13	
	4	CL-CH LEAN TO FAT CLAY. WITH SILT. SAME AS ABOVE EXCEPT STIFF			B67-SB 96-0206 2x4oz 2x8oz	4	START = 1110 STOP = 1111
						7	
	5		HEADSPACE 0		B67-SB 96-0206 -01 2x4oz 2x8oz	7	N = 14 REC. = 1.4'
						8	
	6	CL-CH LEAN TO FAT CLAY WITH SILT. SAME AS ABOVE EXCEPT MEDIUM STIFF AND STICKY				2	START 1118 STOP 1119
			HEADSPACE 0			3	
	7					4	N = 7 REC. = 2.0'
						4	
	8	CL-CH LEAN TO FAT CLAY WITH SILT. SAME AS ABOVE				2	START 1251 STOP 1251
			HEADSPACE 0		B67-SB 96-0210 2x4oz 2x8oz	2	
	9					2	N = 4 REC. = 2.0'
						3	
	10						

PROJECT FT. DES MOINES BLDG. 67

HOLE NO. SB/MW96-2

HTRW DRILLING LOG (CONTINUATION SHEET)							HOLE NUMBER SB/MW96-2
PROJECT FT. DES MOINES BLDG. 67		INSPECTOR CAROLYN SCHWAFEL				SHEET 3 OF 5	
ELEV. (a)	DEPTH (b)	DESCRIPTION OF MATERIALS (c)	FIELD SCREENING RESULTS (d)	GEOTECH SAMPLE OR CORE BOX NO. (e)	ANALYTICAL SAMPLE NO. (f)	BLOW COUNT (g)	REMARKS (h)
	11	CL-CH LEAN TO FAT CLAY, WITH SILT, MEDIUM STIFF, MEDIUM TO HIGH PLASTICITY, MOIST, STICKY, MEDIUM BROWN WITH IRON STAINING	HEADSPACE N/A			1	START 1257 STOP 1258
						2	N = 5 REC. = 2.0'
						3	
						4	
	12	CL-CH LEAN TO FAT CLAY, SAME AS ABOVE				2	START 1304 STOP 1305
						4	
	13		HEADSPACE N/A			4	N = 8 REC. = 2.0'
						5	
	14	CL-CH LEAN TO FAT CLAY WITH SAND AND GRAVEL, 10% FINE GRAINED SAND WITH FINE GRAVEL, MEDIUM TO HIGH PLASTICITY, STIFF, MOIST, MEDIUM BROWN WITH IRON STAINING				2	START 1312 STOP 1313
						4	
	15		HEADSPACE N/A			7	N = 11 REC. = 2.0'
						10	
	16	CH - FAT CLAY - HIGH PLASTICITY, STIFF, MEDIUM BROWN				4	START 1334 STOP 1335
		CL-CH LEAN TO FAT CLAY WITH SAND 10% TRACE OF GRAVEL, FINE SAND AND GRAVEL, MOIST, MEDIUM PLASTICITY, VERY STIFF, BROWN	HEADSPACE N/A	17.0		6	N = 15 REC. = 2.0'
	17			D-1		9	
1338 ▽						12	WATER ENCOUNTERED @17.9'
	18			18.0		4	START 1344 STOP 1345
		COBBLE LAYER				8	
	19	CL-CH LEAN TO FAT CLAY WITH SAND, HIGH PLASTICITY, RED BROWN, AND GRAY, MOIST, VERY STIFF, FINE GRAINED SAND	HEADSPACE N/A			10	N = 18 REC. = 2.0'
						13	
	20						

PROJECT FT. DES MOINES BLDG. 67

HOLE NO. SB/MW96-2

HTRW DRILLING LOG (CONTINUATION SHEET)

PROJECT FT. DES MOINES BLDG. 67 INSPECTOR CAROLYN SCHWAFEL HOLE NUMBER SB/MW96-2 SHEET 4 OF 5 SHEETS

ELEV. (a)	DEPTH (b)	DESCRIPTION OF MATERIALS (c)	FIELD SCREENING RESULTS (d)	GEOTECH SAMPLE OR CORE BOX NO. (e)	ANALYTICAL SAMPLE NO. (f)	BLOW COUNT (g)	REMARKS (h)
	21	SM-ML SILTY SAND, MEDIUM DENSE NON- PLASTIC, DRY, MICA FLAKES, MEDIUM BROWN WITH RUST STAINING, VERY FINE SAND				5	START 1349 STOP 1351
						10	
						14	N = 24 REC. = 2.0'
						15	
	22	SM-ML SAME AS ABOVE				6	START 1402 STOP 1404
						12	
	23					13	N = 25 REC. = 1.8'
						18	
	24	SM-ML SILTY LEAN SAND, SAME AS ABOVE				18	START 1413 STOP 1414
						13	
	25					16	N = 29 REC. = 1.8'
						20	
	26	SM-ML SILTY LEAN SAND, SAME AS ABOVE EXCEPT DENSE				8	START 1440 STOP 1443
						13	
	27					19	N = 32 REC. = 2.0'
						23	
	28	SM-ML SILTY LEAN SAND, SAME AS ABOVE				7	START 1451 STOP 1454
						14	
	29					28	N = 42 REC. = 2.0'
						44	
	30						

PROJECT FT. DES MOINES BLDG. 67 HOLE NO. SB/MW96-2

HTRW DRILLING LOG (CONTINUATION SHEET)							HOLE NUMBER SB/MW96-2
PROJECT FT. DES MOINES BLDG. 67		INSPECTOR CAROLYN SCHWAFEL				SHEET 5 OF 5	
ELEV. (a)	DEPTH (b)	DESCRIPTION OF MATERIALS (c)	FIELD SCREENING RESULTS (d)	GEOTECH SAMPLE OR CORE BOX NO. (e)	ANALYTICAL SAMPLE NO. (f)	BLOW COUNT (g)	REMARKS (h)
	31	SM-ML SILTY SAND VERY DENSE, NONPLASTIC, MICA FLAKES, MEDIUM BROWN WITH IRON STAINING, VERY FINE SAND, DRY				19	START 1505 STOP 1508 N = 101 REC. = 1.4' REFUSAL @ 31.5'
						41	
						60	
		BOTTOM OF HOLE = 31.5'					
	32						MONITORING WELL INSTALLED ON 7-19-96 (SEE WELL DIAGRAM)
	33						
	34						
	35						

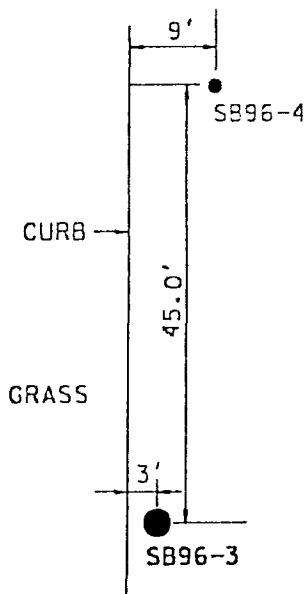
PROJECT FT. DES MOINES BLDG. 67

HOLE NO. SB/MW96-2

HTRW DRILLING LOG				DISTRICT MRO		HOLE NUMBER SB96-3	
1. COMPANY NAME USACE				2. DRILL SUBCONTRACTOR CEMROEDGG		SHEET 1 OF 2 SHEETS	
3. PROJECT FT. DES MOINES BLDG. 67				4. LOCATION DES MOINES, IA.			
5. NAME OF DRILLER AL OAKS				6. MANUFACTURER'S DESIGNATION OF DRILL GUS PECH 1100C			
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT				8. HOLE LOCATION SEE BELOW			
4 1/4" ID HSA. BULLET BIT. 3" OD SPLIT SPOON (STAINLESS STEEL)				9. SURFACE ELEVATION			
				10. DATE STARTED 07-24-96		11. DATE COMPLETED 07-24-96	
12. OVERBURDEN THICKNESS -				15. DEPTH GROUNDWATER ENCOUNTERED NOT ENCOUNTERED			
13. DEPTH DRILLED INTO ROCK 0				16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED NOT ENCOUNTERED			
14. TOTAL DEPTH OF HOLE 10.0' FT.				17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)			
18. GEOTECHNICAL SAMPLES		DISTURBED 0		UNDISTURBED 0		19. TOTAL NUMBER OF CORE BOXES 0	
20. SAMPLES FOR CHEMICAL ANALYSIS		VOC 8 x 4oz		PP METALS Pest 4 x 4oz		OTHER (SPECIFY) Herb 4x4oz	
		BACKFILLED 07-25-96		MONITORING WELL		OTHER (SPECIFY) -	
22. DISPOSITION OF HOLE				23. SIGNATURE OF INSPECTOR CAROLYN SCHWAFEL		21. TOTAL CORE RECOVERY %	
LOCATION SKETCH/COMMENTS				ALL MEASUREMENTS FROM THE CURB ARE TAKEN FROM GRASS SIDE		SCALE 1" = 20'	



BLANK PARK



GRAVEL PARKING AREA
(FORMER BLDG. 67)

HTRW DRILLING LOG (CONTINUATION SHEET)

HOLE NUMBER
SB96-3

PROJECT FT. DES MOINES BLDG. 67

INSPECTOR CAROLYN SCHWAFEL

SHEET 2 OF 2 SHEETS

ELEV. (a)	DEPTH (b)	DESCRIPTION OF MATERIALS (c)	FIELD SCREENING RESULTS (d)	GEOTECH SAMPLE OR CORE BOX NO. (e)	ANALYTICAL SAMPLE NO. (f)	BLOW COUNT (g)	REMARKS (h)
	1	GRAVEL CL-CH LEAN TO FAT CLAY WITH SILT AND GRAVEL, VERY STIFF, MEDIUM TO HIGH PLASTICITY, GRAVEL 10-15% COARSE, ANGULAR, DRY, DARK BROWN	CALIBRATED HNU WITH 100 PPM ISOBUTYLENE @ 240 PSI			10	3" OD SPLIT SPOON 7-24-96 START 0830 STOP 0832
						9	
						11	N (BLOWS) = 20 REC. (RECOVERY) = 0.4' NOT ENOUGH FOR SAMPLE
			HEADSPACE 0.2			12	
	2	CL-CH LEAN TO FAT CLAY WITH SILT AND GRAVEL SAME AS ABOVE EXCEPT LESS STIFF				4	START 0838 STOP 0839
						5	
	3		HEADSPACE 0.2			8	N = 13 REC. = 0.3' NOT ENOUGH FOR SAMPLE
						8	
	4	CL-CH LEAN TO FAT CLAY, WITH TRACE OF SILT, MEDIUM TO HIGH PLASTICITY, STIFF, STICKY, TAN AND GRAY WITH RUST STAINING, MOIST				2	START 0843 STOP 0844
					B67-SB 96-0306 2x4oz 2x8oz PP METALS HERB. VOA	4	N = 10 REC. = 1.3'
	5		HEADSPACE 0.2			6	
						7	
	6	CH-FAT CLAY WITH TRACE OF SILT, HIGH PLASTICITY, MEDIUM STIFF, MOIST, TAN AND GRAY WITH IRON OXIDE STAINING				2	START 0849 STOP 0849
					B67-SB 96-0306 -01 2x4oz 2x8oz	2	N = 5 REC. = 2.0'
	7		HEADSPACE 0.4			3	
					B67-SB 96-0308 2x4oz 2x8oz	4	
	8	CH - FAT CLAY SAME AS ABOVE				2	START 0919 STOP 0919
						3	N = 6 REC. = 1.9'
	9		HEADSPACE 0.2		B67-SB 96-0310 2x4oz 2x8oz	3	
						3	
	10	BOTTOM OF HOLE 10.0'				3	CAVE TO 6.5' GROUTED ON 07-25-96

PROJECT FT. DES MOINES BLDG. 67

HOLE NO. SB96-3

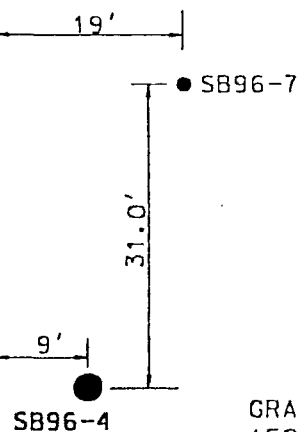
HTRW DRILLING LOG				DISTRICT MRO		HOLE NUMBER SB96-4	
1. COMPANY NAME USACE				2. DRILL SUBCONTRACTOR CEMROEDGG		SHEET 1 OF 2 SHEETS	
3. PROJECT FT. DES MOINES BLDG. 67				4. LOCATION DES MOINES, IA.			
5. NAME OF DRILLER AL OAKS				6. MANUFACTURER'S DESIGNATION OF DRILL GUS PECH 1100C			
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT				8. HOLE LOCATION SEE BELOW			
4 1/4" ID HSA. BULLET BIT, 3" OO SPLIT SPOON (STAINLESS STEEL)				9. SURFACE ELEVATION			
				10. DATE STARTED 07-23-96		11. DATE COMPLETED 07-23-96	
12. OVERBURDEN THICKNESS -				15. DEPTH GROUNDWATER ENCOUNTERED NOT ENCOUNTERED			
13. DEPTH DRILLED INTO ROCK 0				16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED			
14. TOTAL DEPTH OF HOLE 10.0' FT.				17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)			
18. GEOTECHNICAL SAMPLES		DISTURBED 0		UNOISTURBED 0		19. TOTAL NUMBER OF CORE BOXES 0	
20. SAMPLES FOR CHEMICAL ANALYSIS		VOC 8 x 4oz		PP METALS Pest 3 x 8oz		OTHER (SPECIFY) Herb 3x8oz	
		BACKFILLED 07-25-96		MONITORING WELL		OTHER (SPECIFY) -	
22. DISPOSITION OF HOLE				23. SIGNATURE OF INSPECTOR CAROLYN SCHWAFEL		21. TOTAL CORE RECOVERY %	
LOCATION SKETCH/COMMENTS				ALL MEASUREMENTS FROM THE CURB ARE TAKEN FROM GRASS SIDE		SCALE 1" = 20'	



BLANK PARK

GRASS

CURB

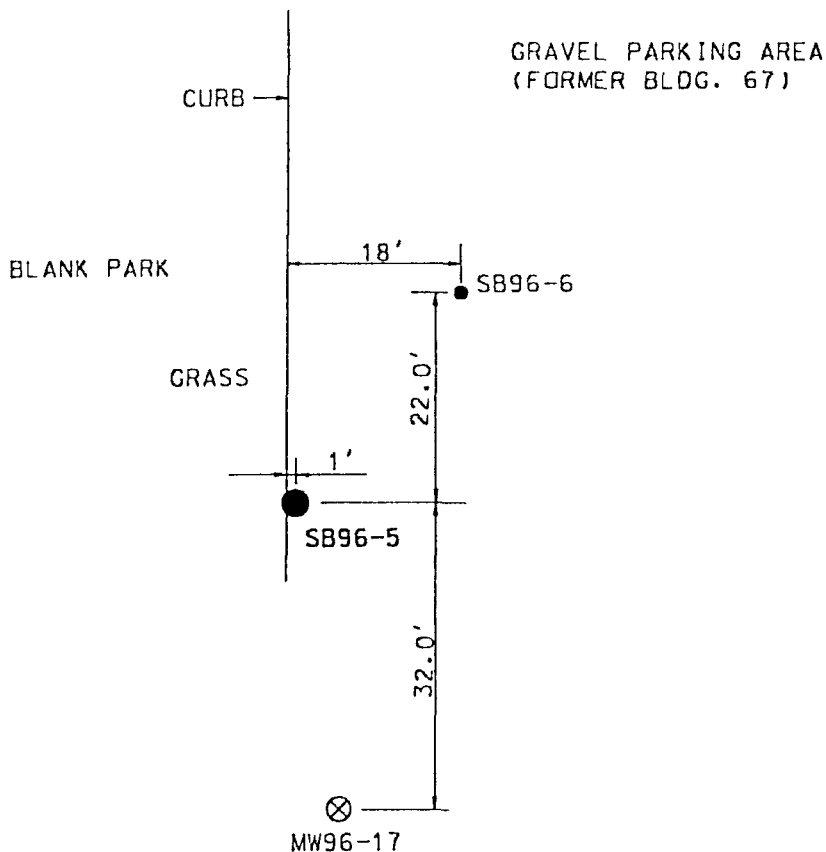
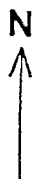


HTRW DRILLING LOG (CONTINUATION SHEET)							HOLE NUMBER SB96-4
PROJECT FT. DES MOINES BLDG. 67		INSPECTOR CAROLYN SCHWAFEL				SHEET 2 OF 2	
ELEV. (a)	DEPTH (b)	DESCRIPTION OF MATERIALS (c)	FIELD SCREENING RESULTS (d)	GEOTECH SAMPLE OR CORE BOX NO. (e)	ANALYTICAL SAMPLE NO. (f)	BLOW COUNT (g)	REMARKS (h)
	1	GRAVEL CL - LEAN CLAY WITH SILT AND SOME GRAVEL, VERY STIFF, MEDIUM PLASTICITY, COARSE ANGULAR GRAVEL, DARK BROWN, DRY	CALIBRATED HNU WITH 100 PPM ISOBUTYLENE @ 240 PSI			12	3" OD SPLIT SPOON 7-23-96 START 1428 STOP 1429
						11	
						11	N (BLOWS) = 22 REC. (RECOVERY) = 0.5' NOT ENOUGH FOR SAMPLE
			HEADSPACE < 1			6	
	2	CL - LEAN CLAY WITH SILT SAME AS ABOVE EXCEPT STIFF				4	START 1438 STOP 1439
						5	
	3		HEADSPACE < 1		B67-SB 96-0404 2x4oz 2x8oz	6	N = 11 REC. = 0.7'
						10	
	4	CL-CH LEAN TO FAT CLAY, WITH TRACE OF SILT, STIFF, HIGH PLASTICITY, MOIST, STICKY, BROWN WITH RUST STAINING				3	START 1445 STOP 1446
						5	
	5		HEADSPACE < 1		B67-SB 96-0406 2x4oz 2x8oz	7	N = 12 REC. = 1.7'
						8	
	6	CL-CH LEAN TO FAT CLAY MEDIUM STIFF, MEDIUM TO HIGH PLASTICITY, MOIST, STIFF, BROWN AND GRAY WITH IRON STAINING				2	START 1451 STOP 1452
						3	
	7		HEADSPACE < 1			3	N = 6 REC. = 2.0'
						4	
	8	CL-CH LEAN TO FAT CLAY SAME AS ABOVE				2	START 1507 STOP 1507
						2	
	9		HEADSPACE < 1			3	N = 5 REC. = 2.0'
						2	
	10	BOTTOM OF HOLE 10.0'			B67-SB 96-0410 2x4oz 2x8oz	2	CAVE TO 5.0' GROUTED ON 07-25-96

PROJECT FT. DES MOINES BLDG. 67

HOLE NO. SB96-4

HTRW DRILLING LOG			DISTRICT MRO			HOLE NUMBER SB96-5			
1. COMPANY NAME USACE			2. DRILL SUBCONTRACTOR CEMROEDGG			SHEET 1 OF 2 SHEETS			
3. PROJECT FT. DES MOINES BLDG. 67			4. LOCATION DES MOINES, IA.						
5. NAME OF DRILLER AL OAKS			6. MANUFACTURER'S DESIGNATION OF DRILL GUS PECH 1100C						
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT			8. HOLE LOCATION SEE BELOW						
4 1/4" ID HSA. BULLET BIT, 3" OD SPLIT SPOON (STAINLESS STEEL)			9. SURFACE ELEVATION						
			10. DATE STARTED 07-23-96			11. DATE COMPLETED 07-23-96			
12. OVERBURDEN THICKNESS -			15. DEPTH GROUNDWATER ENCOUNTERED NOT ENCOUNTERED						
13. DEPTH DRILLED INTO ROCK 0			16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED						
14. TOTAL DEPTH OF HOLE 10.0' FT.			17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)						
18. GEOTECHNICAL SAMPLES		DISTURBED 0		UNDISTURBED 0		19. TOTAL NUMBER OF CORE BOXES 0			
20. SAMPLES FOR CHEMICAL ANALYSIS		VOC		PP METALS Pest		OTHER (SPECIFY)		OTHER (SPECIFY)	
		6 x 4oz		3 x 8oz		Herb 3x8oz		-	
22. DISPOSITION OF HOLE		BACKFILLED		MONITORING WELL		OTHER (SPECIFY)		23. SIGNATURE OF INSPECTOR	
		07-25-96				-		CAROLYN SCHWAFEL	
LOCATION SKETCH/COMMENTS			ALL MEASUREMENTS FROM THE CURB ARE TAKEN FROM GRASS SIDE				SCALE 1" = 20'		



PROJECT FT. DES MOINES BLDG. 67

HOLE NO. SB96-5

HTRW DRILLING LOG (CONTINUATION SHEET)

HOLE NUMBER
SB96-5

PROJECT FT. DES MOINES BLDG. 67

INSPECTOR CAROLYN SCHWAFEL

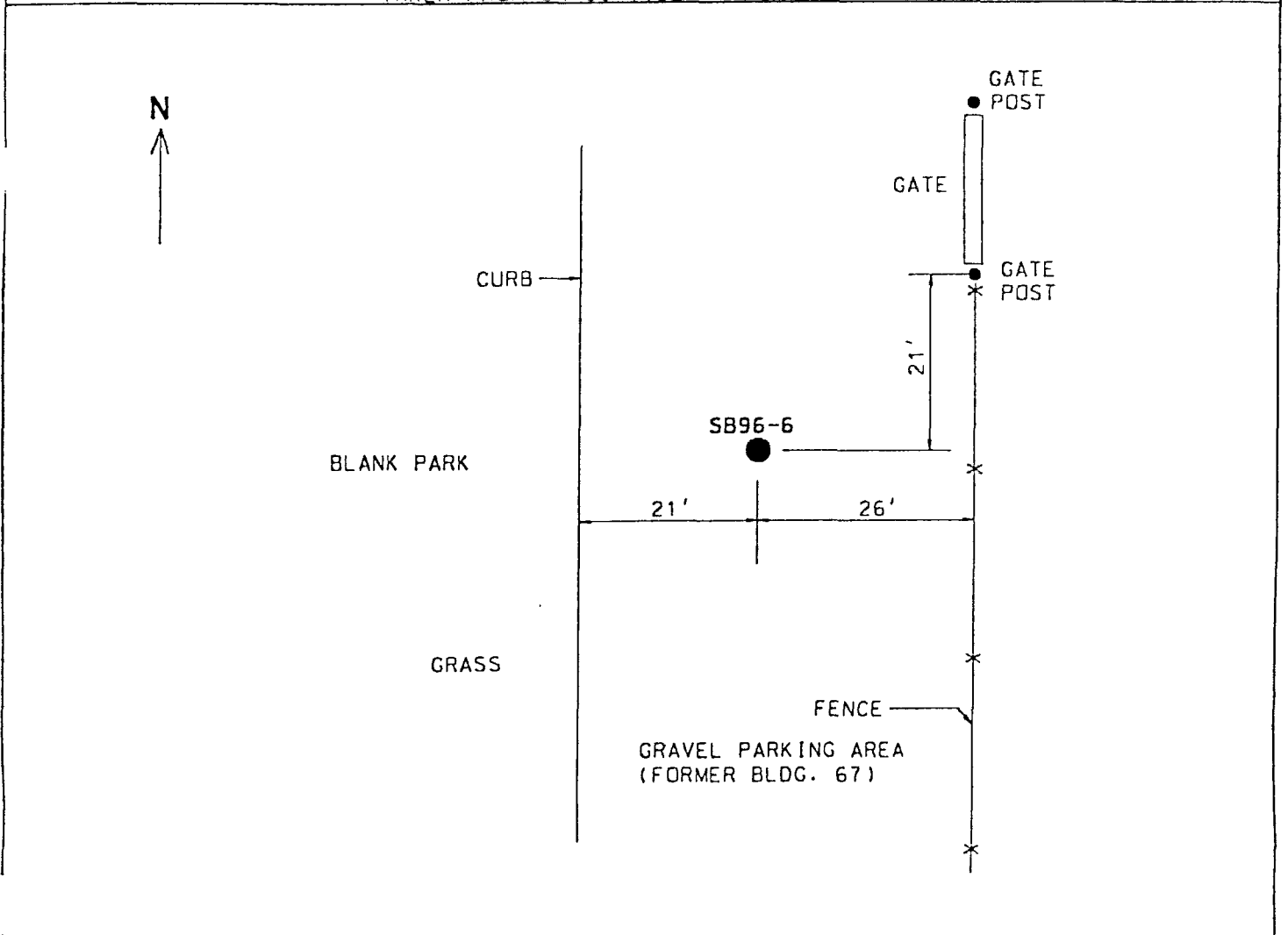
SHEET 2 OF 2 SHEETS

ELEV. (a)	DEPTH (b)	DESCRIPTION OF MATERIALS (c)	FIELD SCREENING RESULTS (d)	GEOTECH SAMPLE OR CORE BOX NO. (e)	ANALYTICAL SAMPLE NO. (f)	BLOW COUNT (g)	REMARKS (h)
		GRAVEL	CALIBRATED				3" OD SPLIT SPOON
		CL - LEAN CLAY WITH	HNU WITH			9	7-23-96
		SILT AND GRAVEL, (10%)	100 PPM			10	START 0949
		VERY STIFF, MEDIUM	ISOBUTYLENE			13	STOP 0951
		PLASTICITY, DRY, DARK	@ 240 PSI		B67-SB		N (BLOWS) = 23
		BROWN			96-0502		REC. (RECOVERY)
					2x4oz		= 1.1'
					2x8oz		
			HEADSPACE			21	
			0.4				
		CL - LEAN CLAY WITH				6	START 1015
		SILT, VERY STIFF,				8	STOP 1016
		MEDIUM PLASTICITY, DRY,					
		LIGHT AND DARK BROWN			B67-SB		N = 17
			HEADSPACE		96-0504		REC. = 0.9'
			0.6		2x4oz		
					2x8oz		
						10	
		CL - LEAN CLAY WITH				4	START 1021
		SILT, STIFF, MEDIUM				4	STOP 1022
		PLASTICITY, DRY, DARK					
		BROWN				4	N = 8
			HEADSPACE			4	REC. = 0.1'
			0.4			4	POOR RECOVERY
						4	NOT ENOUGH FOR
							SAMPLE
		CL-CH LEAN TO FAT CLAY				3	START 1035
		STIFF, MEDIUM				6	STOP 1036
		PLASTICITY, DRY, WITH					
		GRAVEL AND BRICK				5	N = 11
		DEBRIS, DARK BROWN				7	REC. = 1.1'
			HEADSPACE				
			0.6				
		CL-CH LEAN TO FAT CLAY				3	START 1045
		SAME AS ABOVE				4	STOP 1045
		CH - FAT CLAY, STIFF,					
		HIGH PLASTICITY, MOIST,				4	N = 8
		STICKY, GRAY, MEDIUM					REC. = 0.9'
		BROWN WITH RUST	HEADSPACE				
		STAINING	0.8		B67-SB		
					96-0510		
					2x4oz		
					2x8oz		
						5	CAVE TO 2.5'
							GROUTED ON
							07-25-96
		BOTTOM OF HOLE 10.0'					

PROJECT FT. DES MOINES BLDG. 67

HOLE NO. SB96-5

HTRW DRILLING LOG		DISTRICT MRO		HOLE NUMBER SB96-6	
1. COMPANY NAME USACE		2. DRILL SUBCONTRACTOR CEMROEDGG		SHEET 1 OF 2 SHEETS	
3. PROJECT FT. DES MOINES BLDG. 67		4. LOCATION DES MOINES, IA.			
5. NAME OF DRILLER AL OAKS		6. MANUFACTURER'S DESIGNATION OF DRILL GUS PECH 1100C			
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT		8. HOLE LOCATION SEE BELOW			
4 1/4" ID HSA. BULLET BIT, 3" OD SPLIT SPOON (STAINLESS STEEL)		9. SURFACE ELEVATION			
		10. DATE STARTED 07-23-96		11. DATE COMPLETED 07-23-96	
12. OVERBURDEN THICKNESS -		15. DEPTH GROUNDWATER ENCOUNTERED NOT ENCOUNTERED			
13. DEPTH DRILLED INTO ROCK 0		16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED			
14. TOTAL DEPTH OF HOLE 10.0' FT.		17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)			
18. GEOTECHNICAL SAMPLES		DISTURBED 0		UNDISTURBED 0	
19. TOTAL NUMBER OF CORE BOXES 0					
20. SAMPLES FOR CHEMICAL ANALYSIS		VOC		PP METALS Pest	OTHER (SPECIFY)
		6 x 4oz		3 x 8oz	Herb 3x8oz
21. TOTAL CORE RECOVERY %					
22. DISPOSITION OF HOLE		BACKFILLED 07-25-96		MONITORING WELL	OTHER (SPECIFY)
				23. SIGNATURE OF INSPECTOR CAROLYN SCHWAFEL	
LOCATION SKETCH/COMMENTS ALL MEASUREMENTS FROM THE CURB ARE TAKEN FROM GRASS SIDE				SCALE 1" = 20'	



PROJECT FT. DES MOINES BLDG. 67	HOLE NO. SB96-6
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HTRW DRILLING LOG (CONTINUATION SHEET)

HOLE NUMBER
SB96-6

PROJECT FT. DES MOINES BLDG. 67

INSPECTOR CAROLYN SCHWAFEL

SHEET 2 OF 2 SHEETS

ELEV. (a)	DEPTH (b)	DESCRIPTION OF MATERIALS (c)	FIELD SCREENING RESULTS (d)	GEO TECH SAMPLE OR CORE BOX NO. (e)	ANALYTICAL SAMPLE NO. (f)	BLOW COUNT (g)	REMARKS (h)
	1	GRAVEL CL-CH LEAN TO FAT CLAY WITH SILT AND GRAVEL (15%) MEDIUM TO HIGH PLASTICITY, VERY STIFF, DRY, ANGULAR, FINE GRAVEL, MEDIUM BROWN	CALIBRATED HNU WITH 100 PPM ISOBUTYLENE @ 240 PSI			14	3" OD SPLIT SPOON 7-23-96 START 0811 STOP 0813
						13	
						12	N (BLOWS) = 25 REC. (RECOVERY) = 0.5' NOT ENOUGH FOR SAMPLE
			HEADSPACE 0.4			10	
	2	CL-CH LEAN TO FAT CLAY WITH SILT, VERY STIFF, DRY, MEDIUM TO HIGH PLASTICITY, DARK BROWN				3	START 0815 STOP 0816
						7	
	3		HEADSPACE 1.2		B67-SB 96-0604 2x4oz 2x8oz	10	N = 17 REC. = 1.0'
						13	
	4	CL-CH LEAN TO FAT CLAY WITH TRACE OF SILT, STIFF, MOIST, HIGH PLASTICITY, STICKY, MEDIUM BROWN WITH IRON STAINING				3	START 0822 STOP 0823
						6	
	5		HEADSPACE 1.4		B67-SB 96-0606 2x4oz 2x8oz	8	N = 14 REC. = 1.3'
						10	
	6	CH- FAT CLAY WITH TRACE OF SILT, MEDIUM STIFF, HIGH PLASTICITY, STICKY, MOIST, MEDIUM BROWN WITH RUST STAINING				2	START 0829 STOP 0829
						4	
	7		HEADSPACE 1.0		B67-SB 96-0608 2x4oz 2x8oz	4	N = 8 REC. = 2.0'
						5	
	8	CH- FAT CLAY WITH TRACE OF SILT, HIGH PLASTICITY, STICKY, MOIST, MEDIUM BROWN AND GRAY WITH RUST STAINING, MEDIUM STIFF				2	START 0830 STOP 0831
						2	
	9		HEADSPACE 0.8			3	N = 5 REC. = 2.0'
						4	
	10	BOTTOM OF HOLE 10.0'					CAVE TO 7.0' GROUTED ON 07-25-96

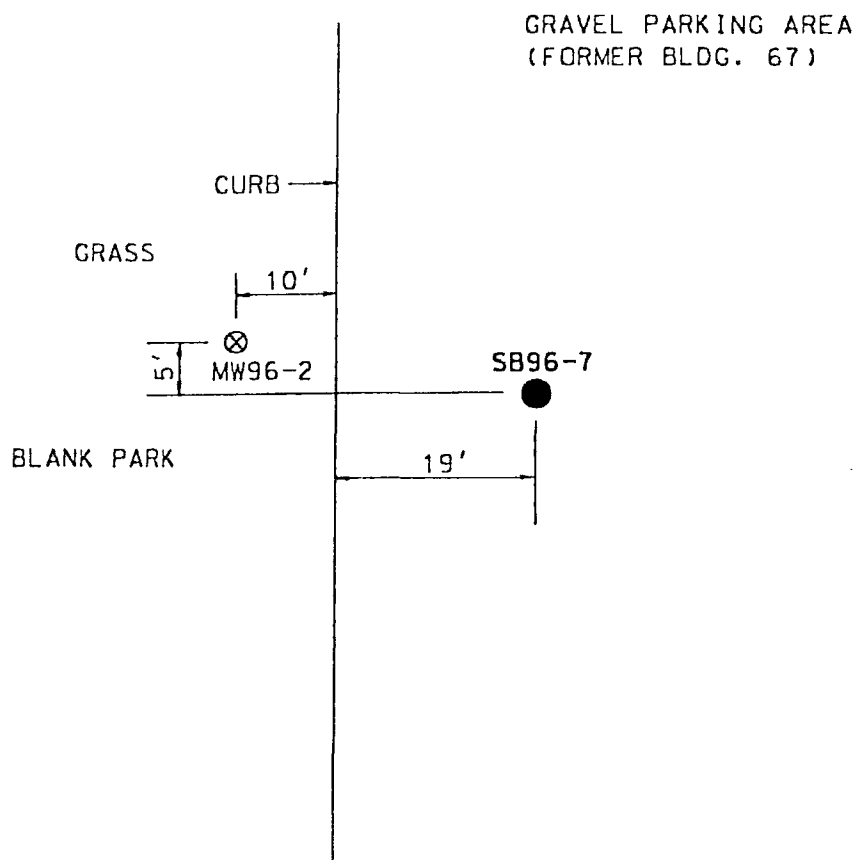
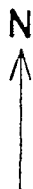
PROJECT FT. DES MOINES BLDG. 67

HOLE NO. SB96-6

HTRW DRILLING LOG			DISTRICT MRO		HOLE NUMBER SB96-7	
1. COMPANY NAME USACE			2. DRILL SUBCONTRACTOR CEMROEDGG		SHEET 1 OF 2 SHEETS	
3. PROJECT FT. DES MOINES BLDG. 67			4. LOCATION DES MOINES, IA.			
5. NAME OF DRILLER AL OAKS			6. MANUFACTURER'S DESIGNATION OF DRILL GUS PECH 1100C			
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT			8. HOLE LOCATION SEE BELOW			
4 1/4" ID HSA. BULLET BIT, 3" OD SPLIT SPOON (STAINLESS STEEL)			9. SURFACE ELEVATION			
			10. DATE STARTED 07-23-96		11. DATE COMPLETED 07-23-96	
12. OVERBURDEN THICKNESS -			15. DEPTH GROUNDWATER ENCOUNTERED NOT ENCOUNTERED			
13. DEPTH DRILLED INTO ROCK 0			16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED			
14. TOTAL DEPTH OF HOLE 10.0' FT.			17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)			
18. GEOTECHNICAL SAMPLES		DISTURBED 0	UNDISTURBED 0	19. TOTAL NUMBER OF CORE BOXES 0		
20. SAMPLES FOR CHEMICAL ANALYSIS		VOC 8 x 4oz	PP METALS Pest 4 x 8oz	OTHER (SPECIFY) Herb 4x8oz	OTHER (SPECIFY) -	OTHER (SPECIFY) -
22. DISPOSITION OF HOLE		BACKFILLED 07-25-96	MONITORING WELL	OTHER (SPECIFY) -	21. TOTAL CORE RECOVERY %	
				23. SIGNATURE OF INSPECTOR CAROLYN SCHWAFEL		

LOCATION SKETCH/COMMENTS ALL MEASUREMENTS FROM THE CURB ARE TAKEN FROM GRASS SIDE

SCALE 1" = 20'



PROJECT FT. DES MOINES BLDG. 67

HOLE NO. SB96-7

HTRW DRILLING LOG (CONTINUATION SHEET)

HOLE NUMBER
SB96-7

PROJECT FT. DES MOINES BLDG. 67

INSPECTOR CAROLYN SCHWAFEL

SHEET 2 OF 2 SHEETS

ELEV. (a)	DEPTH (b)	DESCRIPTION OF MATERIALS (c)	FIELD SCREENING RESULTS (d)	GEOTECH SAMPLE OR CORE BOX NO. (e)	ANALYTICAL SAMPLE NO. (f)	BLOW COUNT (g)	REMARKS (h)
	1	GRAVEL CL- LEAN CLAY WITH SILT, VERY STIFF, MEDIUM PLASTICITY, DRY, DARK BROWN	CALIBRATED HNU WITH 100 PPM ISOBUTYLENE @ 240 PSI		B67-SB 96-0702 2x4oz 2x8oz	13 12 10 9	3" OD SPLIT SPOON 7-23-96 START 1242 STOP 1243 N (BLOWS) = 22 REC. (RECOVERY) = 0.9'
	2	CL- LEAN CLAY WITH SILT SAME AS ABOVE	HEADSPACE 0.6			5 7 9 10	START 1252 STOP 1253 N = 16 REC. = 1.1'
	3		HEADSPACE 0.6			3 5 5 8	START 1257 STOP 1257 N = 10 REC. = 1.7'
	4	CH- FAT CLAY, STIFF, HIGH PLASTICITY, MOIST, STICKY, GRAY AND BROWN WITH IRON STAINING			B67-SB 96-0706 2x4oz 2x8oz	2 2 4 5	START 1303 STOP 1303 N = 6 REC. = 2.0'
	5		HEADSPACE 0.6		B67-SB 96-0706 -01 2x4oz 2x8oz	2 2 3 3	START 1313 STOP 1313 N = 5 REC. = 2.0'
	6	CH- FAT CLAY SAME AS ABOVE EXCEPT STIFF			B67-SB 96-0708 2x4oz 2x8oz	2 2 3 3	START 1313 STOP 1313 N = 5 REC. = 2.0'
	7		HEADSPACE 1.0			2 2 3 3	START 1313 STOP 1313 N = 5 REC. = 2.0'
	8	CH- FAT CLAY SAME AS ABOVE				2 2 3 3	START 1313 STOP 1313 N = 5 REC. = 2.0'
	9		HEADSPACE 0.2			2 2 3 3	START 1313 STOP 1313 N = 5 REC. = 2.0'
	10	BOTTOM OF HOLE 10.0'				2 2 3 3	START 1313 STOP 1313 N = 5 REC. = 2.0'

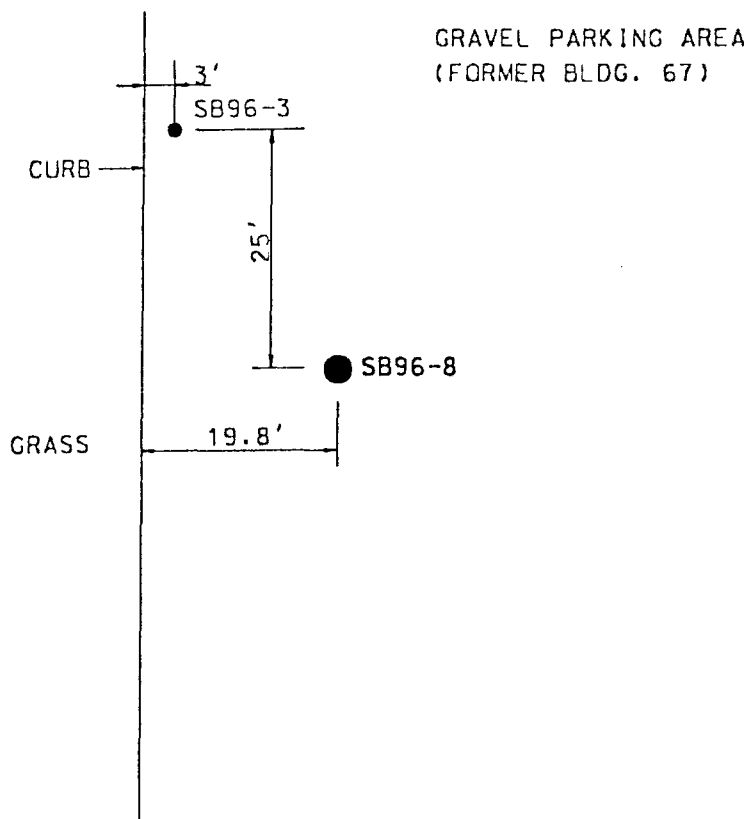
PROJECT FT. DES MOINES BLDG. 67

HOLE NO. SB96-7

HTRW DRILLING LOG				DISTRICT MRO		HOLE NUMBER SB96-8	
1. COMPANY NAME USACE				2. DRILL SUBCONTRACTOR CEMROEDGG		SHEET 1 OF 2 SHEETS	
3. PROJECT FT. DES MOINES BLDG. 67				4. LOCATION DES MOINES, IA.			
5. NAME OF DRILLER AL OAKS				6. MANUFACTURER'S DESIGNATION OF DRILL GUS PECH 1100C			
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT				8. HOLE LOCATION SEE BELOW			
4 1/4" ID HSA. BULLET BIT. 3" OD SPLIT SPOON (STAINLESS STEEL)				9. SURFACE ELEVATION			
				10. DATE STARTED 07-24-96		11. DATE COMPLETED 07-24-96	
12. OVERBURDEN THICKNESS -				15. DEPTH GROUNDWATER ENCOUNTERED NOT ENCOUNTERED			
13. DEPTH DRILLED INTO ROCK 0				16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED			
14. TOTAL DEPTH OF HOLE 10.0 FT.				17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)			
18. GEOTECHNICAL SAMPLES		DISTURBED 0		UNDISTURBED 0		19. TOTAL NUMBER OF CORE BOXES 0	
20. SAMPLES FOR CHEMICAL ANALYSIS		VOC 6 x 4oz		PP METALS Pest 3 x 8oz		OTHER (SPECIFY) Herb 3x8oz	
		BACKFILLED 07-25-96		MONITORING WELL		OTHER (SPECIFY) -	
22. DISPOSITION OF HOLE				23. SIGNATURE OF INSPECTOR CAROLYN SCHWAFEL		21. TOTAL CORE RECOVERY %	
LOCATION SKETCH/COMMENTS				ALL MEASUREMENTS FROM THE CURB ARE TAKEN FROM GRASS SIDE		SCALE 1" = 20'	

N
↑

BLANK PARK

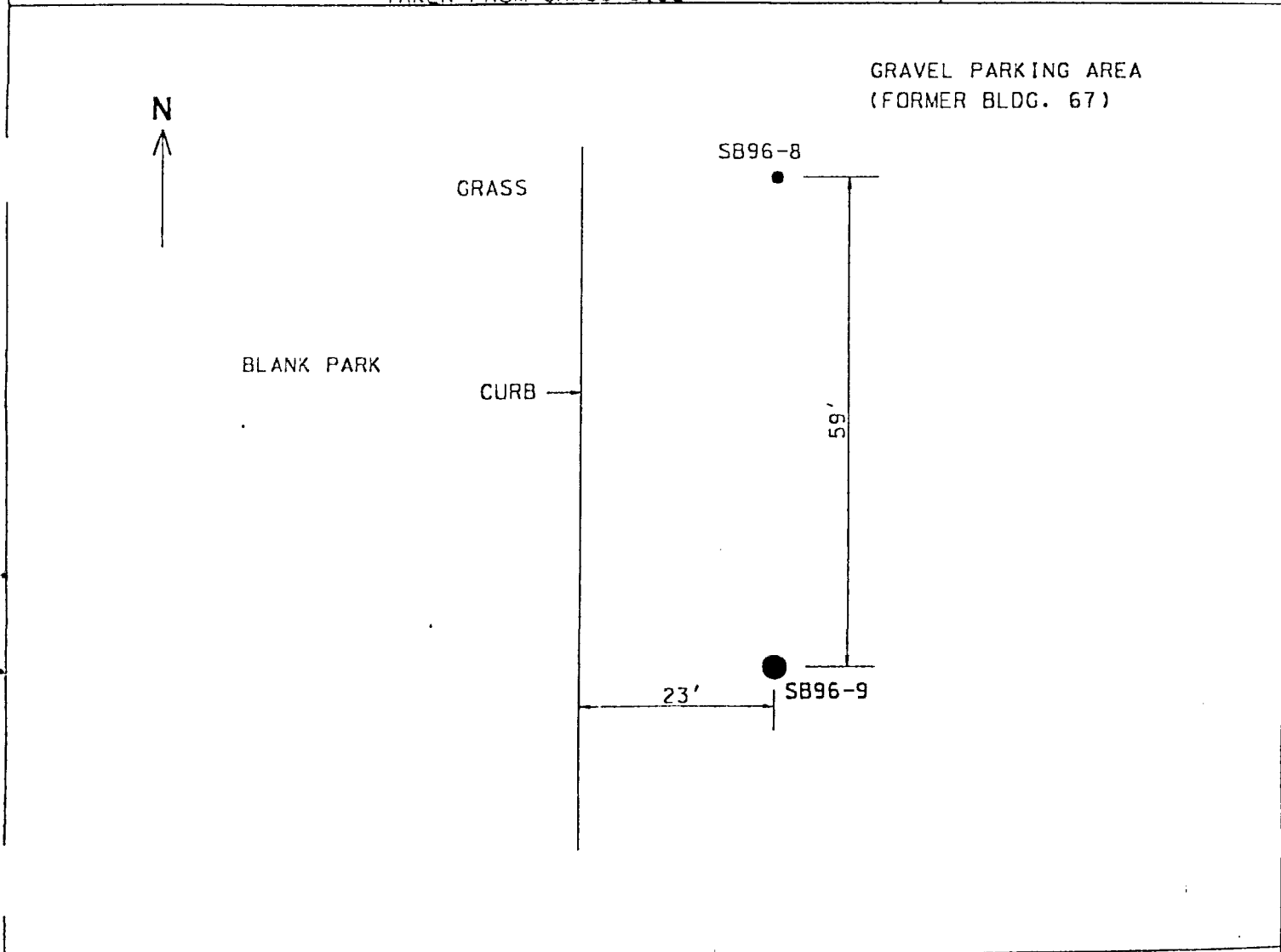


HTRW DRILLING LOG (CONTINUATION SHEET)							HOLE NUMBER SB96-8
PROJECT FT. DES MOINES BLDG. 67		INSPECTOR CAROLYN SCHWAFEL			SHEET 2 OF 2		
ELEV. (a)	DEPTH (b)	DESCRIPTION OF MATERIALS (c)	FIELD SCREENING RESULTS (d)	GEOTECH SAMPLE OR CORE BOX NO. (e)	ANALYTICAL SAMPLE NO. (f)	BLOW COUNT (g)	REMARKS (h)
		GRAVEL	CALIBRATED				3" OD SPLIT SPOON
		CH- FAT CLAY WITH	HNU WITH			14	7-24-96
		SILT. VERY STIFF.	100 PPM			12	START 1012
		MEDIUM TO HIGH	ISOBUTYLENE			11	STOP 1014
		PLASTICITY. DRY. DARK	@ 240 PSI		B67-SB		N (BLOWS) = 23
		BROWN BRICK DEBRIS AND			96-0802		REC. (RECOVERY)
		GRAVEL			2x4oz		= 1.1'
					2x8oz		
			HEADSPACE			14	
			0.2				
		CH- FAT CLAY WITH SILT.				4	START 1021
		SAME AS ABOVE. EXCEPT				3	STOP 1021
		MEDIUM STIFF				3	N = 6
			HEADSPACE			3	REC. = 0.7'
			0.4			5	
		CL-CH LEAN TO FAT CLAY.				3	START 1025
		STIFF. MEDIUM TO HIGH				6	STOP 1026
		PLASTICITY. MOIST.			B67-SB		N = 12
		BROWN AND GRAY WITH			96-0806		REC. = 1.6'
		IRON OXIDE STAINING.			2x4oz		
		STICKY			2x8oz		
			HEADSPACE			6	
			0.4			8	
		CL-CH LEAN TO FAT CLAY.				2	START 1030
		MEDIUM STIFF. MEDIUM				3	STOP 1031
		TO HIGH PLASTICITY.				4	N = 7
		MOIST. GRAY WITH IRON				5	REC. = 2.0'
		OXIDE STAINING. STICKY					
			HEADSPACE			2	START 1042
			0.2			2	STOP 1043
		CL-CH FAT TO LEAN CLAY			B67-SB		N = 5
		SAME AS ABOVE			96-0810		REC. = 2.0'
			HEADSPACE		2x4oz		
			0.2		2x8oz		
						4	CAVE TO 6.5'
							GROUTED ON
							07-25-96
		BOTTOM OF HOLE 10.0'					

PROJECT FT. DES MOINES BLDG. 67

HOLE NO. SB96-8

HTRW DRILLING LOG			DISTRICT MRO			HOLE NUMBER SB96-9			
1. COMPANY NAME USACE			2. DRILL SUBCONTRACTOR CEMROEDGG			SHEET 1 OF 2 SHEETS			
3. PROJECT FT. DES MOINES BLDG. 67			4. LOCATION DES MOINES, IA.						
5. NAME OF DRILLER AL OAKS			6. MANUFACTURER'S DESIGNATION OF DRILL GUS PECH 1100C						
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT			8. HOLE LOCATION SEE BELOW						
4 1/4" ID HSA. BULLET BIT, 3" OD SPLIT SPOON (STAINLESS STEEL)			9. SURFACE ELEVATION						
			10. DATE STARTED 07-24-96			11. DATE COMPLETED 07-24-96			
12. OVERBURDEN THICKNESS -			15. DEPTH GROUNDWATER ENCOUNTERED NOT ENCOUNTERED						
13. DEPTH DRILLED INTO ROCK 0			16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED						
14. TOTAL DEPTH OF HOLE 10.0' FT.			17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)						
18. GEOTECHNICAL SAMPLES		DISTURBED 0		UNDISTURBED 0		19. TOTAL NUMBER OF CORE BOXES 0			
20. SAMPLES FOR CHEMICAL ANALYSIS		VOC 6 x 4oz		PP METALS Post 3 x 8oz		OTHER (SPECIFY) Herb 3x8oz		21. TOTAL CORE RECOVERY %	
22. DISPOSITION OF HOLE		BACKFILLED 07-25-96		MONITORING WELL		OTHER (SPECIFY) -		23. SIGNATURE OF INSPECTOR CAROLYN SCHWAFEL	
LOCATION SKETCH/COMMENTS			ALL MEASUREMENTS FROM THE CURB ARE TAKEN FROM GRASS SIDE				SCALE 1" = 20'		



PROJECT FT. DES MOINES BLDG. 67	HOLE NO. SB96-9
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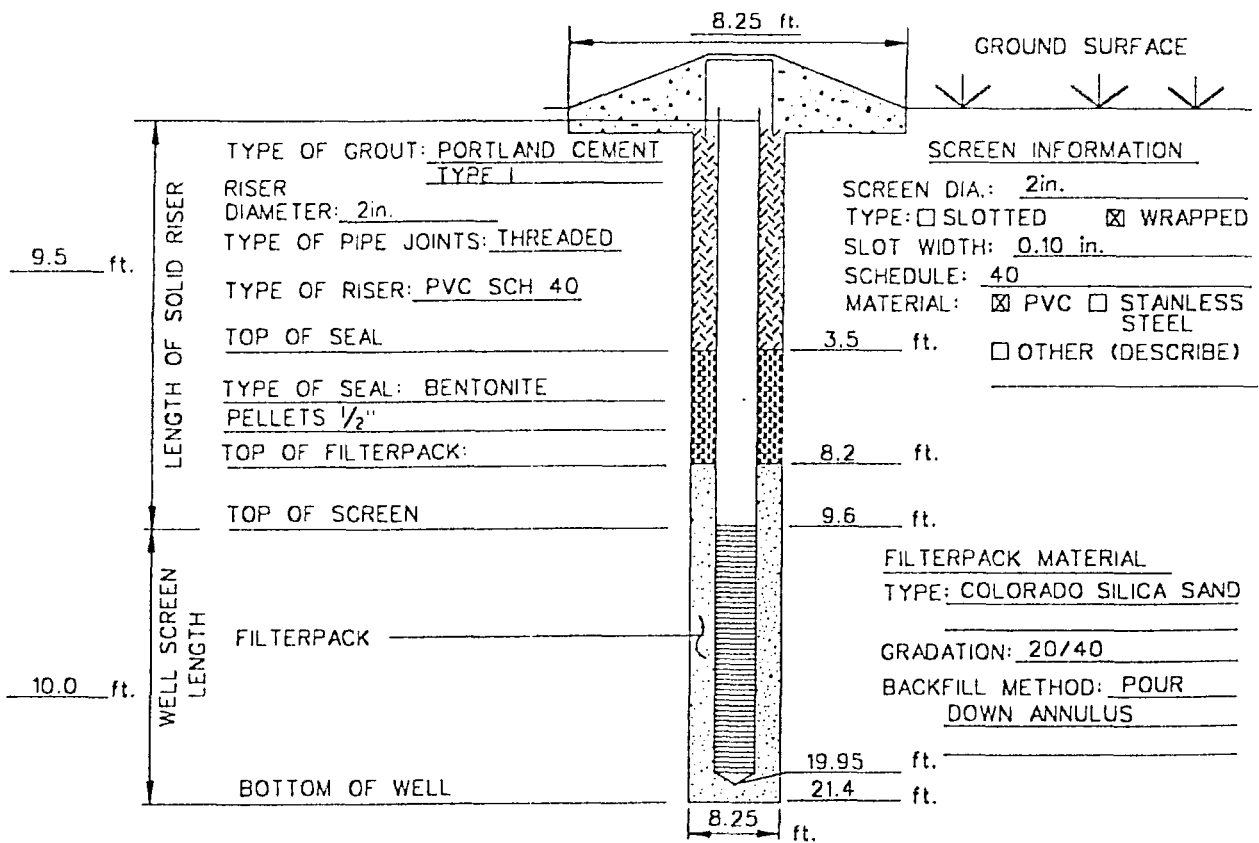
APPENDIX B

WELL COMPLETION DIAGRAMS

HOLE NO. (as shown on drawing title and file number) MW96-01		PROJECT FT. DES MOINES BLDG. 67	
DATE INSTALLED	STARTED 7-22-96	COMPLETED 7-25-96	LOCATION (Coordinates or Station)
ELEVATION TOP OF HOLE		SIGNATURE OF INSPECTOR/INSTALLER CAROLYN SCHWAFEL	
TOTAL DEPTH OF HOLE 21.4'		ELEVATION GROUND WATER (or depth from surface) 10.74' TOC	

FLUSH MOUNT WELL CONSTRUCTION DIAGRAM

(ALL MEASUREMENTS FROM GROUND SURFACE)



WATER LEVEL SUMMARY

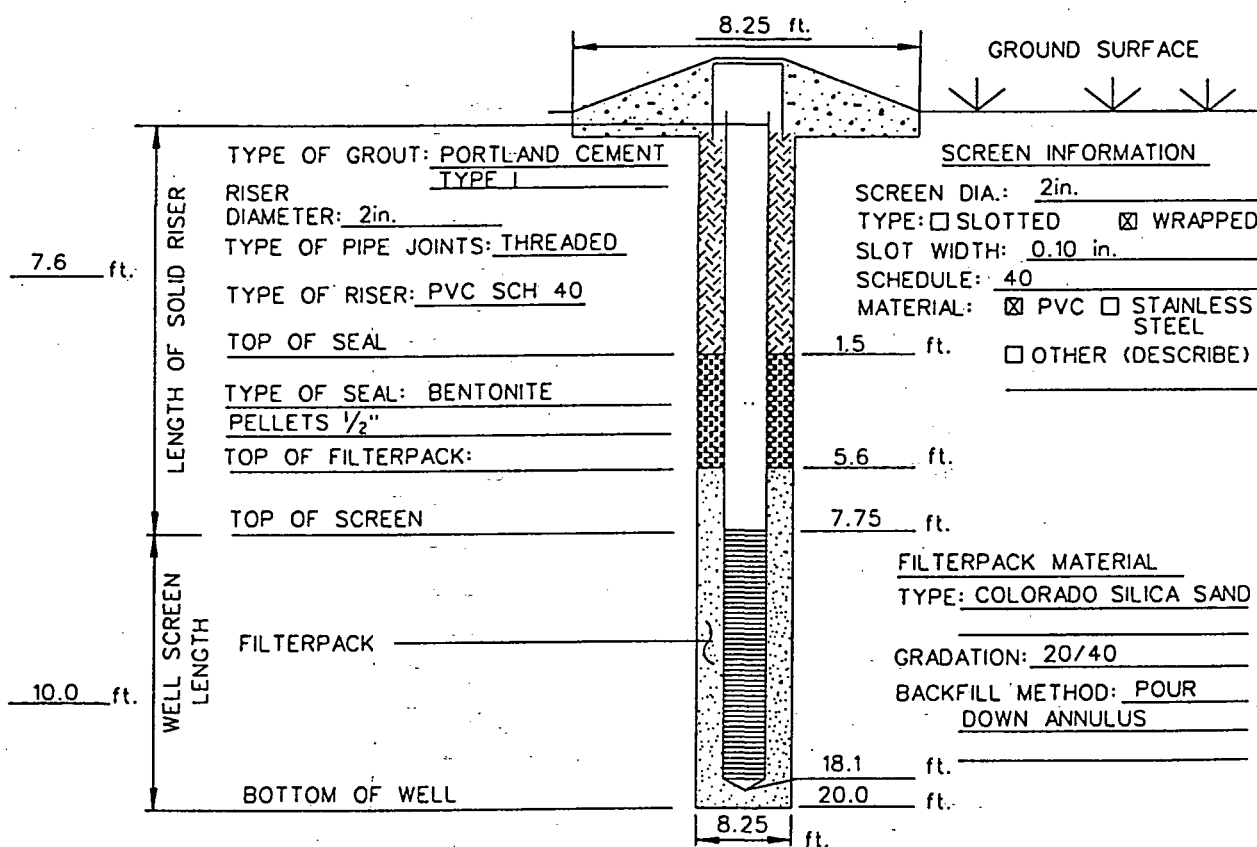
WATER LEVEL MEASUREMENTS

DATE/TIME/LEVEL
7/24/96/0805/10.74'

HOLE NO. (as shown on drawing title and file number) MW96-02		PROJECT FT. DES MOINES BLDG. 67	
DATE INSTALLED	STARTED 7-19-96	COMPLETED 7-25-96	LOCATION (Coordinates or Station)
ELEVATION TOP OF HOLE			SIGNATURE OF INSPECTOR/INSTALLER CAROLYN SCHWAFEL
TOTAL DEPTH OF HOLE 20.0'			ELEVATION GROUND WATER (or depth from surface) 13.78' TOC

FLUSH MOUNT WELL CONSTRUCTION DIAGRAM

(ALL MEASUREMENTS FROM GROUND SURFACE)



WATER LEVEL SUMMARY

WATER LEVEL MEASUREMENTS
DATE/TIME/LEVEL
7/24/96/0900/13.78'

APPENDIX C

WELL PURGE/SAMPLE RECORDS

FIELD RECORD OF WELL GAUGING, PURGING, AND SAMPLING

Project: Former Ft. Des Moines Site: Bldg. 67

Well No: MW96-1 Date: 20 Aug. 96 Time: 10:00

Weather: Warm, sunny & calm

Well Condition: Good

Stick up/down (ft): flush .3 ft Well Diameter (in.): 2.0 nominal

Odor (describe): None

Sounding Method: W/L Meter Measurement Reference: TOC

(1) Well Depth (ft): 19.5 Purge Date: 20 AUG 98 Time: 10:30

(2) Depth to Liquid (ft): _____ Purge Method: Ground for Pump

(3) Depth to Water (ft): 9.0 b TOC Purge Rate: 150 ml/min

(4) Liquid Depth [(1) - (2)]: _____ Purge Time: 40 min

(5) Liquid Volume: _____ Purge Volume: Total 2.0 gal

Sample	Time	pH	Cond. µmho	Temp. °C	Turb. NTU	Remarks (sed., color, clarity, etc.)
Initial	11:40	6.57	635	11.8	7200	Semi-Trans. Brn. Tint
	11:48	6.43	680	11.9	7200	Brown, Dirty
	11:56	6.59	660	12.0	7200	"
	12:04	6.61	647	12.1	7200	"
	12:12	6.60	642	12.3	7200	"
	12:20	6.60	639	12.3	7200	"
Final	12:20	6.60	639	12.3	7200	"

Did Well Pump Dry? Describe: Yes, water level receded to pump intake at end of purging. Began sampling after 30 min. recovery.

Samplers: TFS / CN Sampling Date: 20 AUG 98

Sample Types: VOC, SVOC, Pesticides, metals

Remarks: _____

FIELD RECORD OF WELL GAUGING, PURGING, AND SAMPLING

Project: Former Ft. Des Moines Site: Bldg 67
 Well No: MW96-2 Date: 20 AUG 98 Time: 13:30
 Weather: Warm Sunny & Calm
 Well Condition: Good

Stick up/down (ft): flush .3 ft Well Diameter (in.): 2.0 in nominal

Odor (describe): None

Sounding Method: W/L water Measurement Reference: TOC

(1) Well Depth (ft): 17.8 ft bTOC Purge Date: 20 AUG 98 Time: 1340

(2) Depth to Liquid (ft): _____ Purge Method: _____

(3) Depth to Water (ft): 12.13 ft bTOC Purge Rate: 125 ml/hr

(4) Liquid Depth [(1) - (2)]: _____ Purge Time: 40

(5) Liquid Volume: _____ Purge Volume: 1.5 gal

Sample	Time	pH	Cond. µmho	Temp. °C	Turb. NTU	Remarks (sed., color, clarity, etc.)
Initial	1350	7.63	580	10.2	7200	Good Trans Brn Tint
	1358	7.42	635	10.5	7200	Dark
Pumped Dry	1410					
	1430	7.41	610	12.1	7200	Very Cloudy Brn Tint
Pumped Dry	1435					
Final		7.41	610	12.1	7200	Very Cloudy

Did Well Pump Dry? Describe: Yes, water receded in 4-5 min after 1410.
Well was allowed to pump for 30 min after 1430.

Samplers: TF51CN Sampling Date: 20 AUG 98

Sample Types: VOC, SVOC, Pesticides, Metals

Remarks: Very poor water yields.

APPENDIX D

EPA/540/S-95/504
LOW-FLOW (MINIMAL DRAWDOWN)
GROUNDWATER SAMPLING
PROCEDURES



Ground Water Issue

LOW-FLOW (MINIMAL DRAWDOWN) GROUND-WATER SAMPLING PROCEDURES

by Robert W. Puls¹ and Michael J. Barcelona²

Background

The Regional Superfund Ground Water Forum is a group of ground-water scientists, representing EPA's Regional Superfund Offices, organized to exchange information related to ground-water remediation at Superfund sites. One of the major concerns of the Forum is the sampling of ground water to support site assessment and remedial performance monitoring objectives. This paper is intended to provide background information on the development of low-flow sampling procedures and its application under a variety of hydrogeologic settings. It is hoped that the paper will support the production of standard operating procedures for use by EPA regional personnel and other environmental professionals engaged in ground-water sampling.

For further information contact: Robert Puls, 405-436-8543, Subsurface Remediation and Protection Division, NRMRL, Ada, OK.

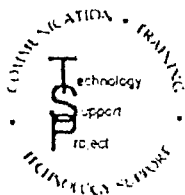
I. Introduction

The methods and objectives of ground-water sampling to assess water quality have evolved over time. Initially the emphasis was on the assessment of water quality of aquifers as sources of drinking water. Large water-

bearing units were identified and sampled in keeping with that objective. These were highly productive aquifers that supplied drinking water via private wells or through public water supply systems. Gradually, with the increasing awareness of subsurface pollution of these water resources, the understanding of complex hydrogeochemical processes which govern the fate and transport of contaminants in the subsurface increased. This increase in understanding was also due to advances in a number of scientific disciplines and improvements in tools used for site characterization and ground-water sampling. Ground-water quality investigations where pollution was detected, initially borrowed ideas, methods, and materials for site characterization from the water supply field and water analysis from public health practices. This included the materials and manner in which monitoring wells were installed and the way in which water was brought to the surface, treated, preserved and analyzed. The prevailing conceptual ideas included convenient generalizations of ground-water resources in terms of large and relatively homogeneous hydrologic "units". With time it became apparent that conventional water supply generalizations of "homogeneity" did not adequately represent field data regarding pollution of these subsurface resources. The important role of "heterogeneity" became increasingly clear not only in geologic terms, but also in terms

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Walter W. Kovalick, Jr., Ph.D.
Director

of complex physical, chemical and biological subsurface processes. With greater appreciation of the role of heterogeneity, it became evident that subsurface pollution was ubiquitous and encompassed the unsaturated zone to the deep subsurface and included unconsolidated sediments, fractured rock, and "aquitards" or low-yielding or impermeable formations. Small-scale processes and heterogeneities were shown to be important in identifying contaminant distributions and in controlling water and contaminant flow paths.

It is beyond the scope of this paper to summarize all the advances in the field of ground-water quality investigations and remediation, but two particular issues have bearing on ground-water sampling today: aquifer heterogeneity and colloidal transport. Aquifer heterogeneities affect contaminant flow paths and include variations in geology, geochemistry, hydrology and microbiology. As methods and the tools available for subsurface investigations have become increasingly sophisticated and understanding of the subsurface environment has advanced, there is an awareness that in most cases a primary concern for site investigations is characterization of contaminant flow paths rather than entire aquifers. In fact, in many cases, plume thickness can be less than well screen lengths (e.g. 3-6 m) typically installed at hazardous waste sites to detect and monitor plume movement over time. Small-scale differences have increasingly been shown to be important and there is a general trend toward smaller diameter wells and shorter screens.

The hydrogeochemical significance of colloidal-size particles in subsurface systems has been realized during the past several years (Gschwend and Reynolds, 1987; McCarthy and Zachara, 1989; Puls, 1990; Ryan and Gschwend, 1990). This realization resulted from both field and laboratory studies that showed faster contaminant migration over greater distances and at higher concentrations than flow and transport model predictions would suggest (Buddemeier and Hunt, 1988; Enfield and Bengtsson, 1988; Penrose et al. 1990). Such models typically account for interaction between the mobile aqueous and immobile solid phases, but do not allow for a mobile, reactive solid phase. It is recognition of this third "phase" as a possible means of contaminant transport that has brought increasing attention to the manner in which samples are collected and processed for analysis (Puls et al. 1990; McCarthy and Degueudre, 1993; Backhus et al. 1993; USEPA 1995). If such a phase is present in sufficient mass, possesses high sorption reactivity, large surface area, and remains stable in suspension, it can serve as an important mechanism to facilitate contaminant transport in many types of subsurface systems.

Colloids are particles that are sufficiently small that the surface free energy of the particle dominates the bulk free energy. Typically, in ground water, this includes particles with diameters between 1 and 1000 nm. The most

commonly observed mobile particles include: secondary clay minerals; hydrous iron, aluminum, and manganese oxides; dissolved and particulate organic materials, and viruses and bacteria. These reactive particles have been shown to be mobile under a variety of conditions in both field studies and laboratory column experiments, and as such need to be included in monitoring programs where identification of the "total" mobile contaminant loading (dissolved + naturally suspended particles) at a site is an objective. To that end, sampling methodologies must be used which do not artificially bias "naturally" suspended particle concentrations.

Currently the most common ground-water purging and sampling methodology is to purge a well using bailers or high speed pumps to remove 3 to 5 casing volumes followed by sample collection. This method can cause adverse impacts on sample quality through collection of samples with high levels of turbidity. This results in the inclusion of otherwise immobile artifactual particles which produce an overestimation of certain analytes of interest (e.g. metals or hydrophobic organic compounds). Numerous documented problems associated with filtration (Danielsson, 1982; Laxen and Chandler, 1982; Horowitz et al. 1992) make this an undesirable method of rectifying the turbidity problem, and include the removal of potentially mobile (contaminant-associated) particles during filtration, thus artificially biasing contaminant concentrations low. Sampling-induced turbidity problems can often be mitigated by using low-flow purging and sampling techniques.

Current subsurface conceptual models have undergone considerable refinement due to the recent development and increased use of field screening tools. So-called hydraulic "push" technologies (e.g. cone penetrometer, Geoprobe®, QED HydroPunch®) enable relatively fast screening site characterization which can then be used to design and install a monitoring well network. Indeed, alternatives to conventional monitoring wells are now being considered for some hydrogeologic settings. The ultimate design of any monitoring system should however be based upon adequate site characterization and be consistent with established monitoring objectives.

If the sampling program objectives include accurate assessment of the magnitude and extent of subsurface contamination over time and/or accurate assessment of subsequent remedial performance then some information regarding plume delineation in three dimensional space is necessary prior to monitoring well network design and installation. This can be accomplished with a variety of different tools and equipment ranging from hand-operated augers to screening tools mentioned above and large drilling rigs. Detailed information on groundwater flow velocity, direction, and horizontal and vertical variability are essential baseline data requirements. Detailed soil and geologic data are required prior to and during the installation of sampling points. This includes historical as well as detailed soil and

geologic logs which accumulate during the site investigation. The use of borehole geophysical techniques are also recommended. With this information (together with other site characterization data) and a clear understanding of sampling objectives, then appropriate location, screen length, well diameter, slot size etc. for the monitoring well network can be decided. This is especially critical for new in situ remedial approaches or natural attenuation assessments at hazardous waste sites.

In general, the overall goal of any ground-water sampling program is to collect water samples with no alteration in water chemistry; analytical data thus obtained may be used for a variety of specific monitoring programs depending on the regulatory requirements. The sampling methodology described in this paper assumes that the monitoring goal is to sample monitoring wells for the presence of contaminants and it is applicable whether mobile colloids are a concern or not and whether the analytes of concern are metals (and metalloids) or organic compounds.

II. Monitoring Objectives and Design Considerations.

The following issues are important to consider prior to the design and implementation of any ground-water monitoring program, including those which anticipate using low-flow purging and sampling procedures.

A. Data Quality Objectives (DQO's)

Monitoring objectives include four main types: detection, assessment, corrective-action evaluation and resource evaluation, along with "hybrid" variations such as site-assessments for property transfers and water availability investigations. Monitoring objectives may change as contamination or water quality problems are discovered. However, there are a number of common components of monitoring programs which should be recognized as important regardless of initial objectives. These components include:

- 1) Development of a conceptual model that incorporates elements of the regional geology to the local geologic framework. The conceptual model development also includes initial site characterization efforts to identify hydrostratigraphic units and likely flow-paths using a minimum number of borings and well completions;
- 2) Cost-effective and well documented collection of high quality data utilizing simple, accurate, and reproducible techniques; and
- 3) Refinement of the conceptual model based on supplementary data collection and analysis.

These fundamental components serve many types of monitoring programs and provide a basis for future efforts

that evolve in complexity and level of spatial detail as purposes and objectives expand. High quality, reproducible data collection is a common goal regardless of program objective.

High quality data collection implies data of sufficient accuracy, precision, and completeness (i.e. ratio of valid analytical results to the minimum sample number called for by the program design) to meet the program objectives. Accuracy depends on the correct choice of monitoring tools and procedures to minimize sample and subsurface disturbance from collection to analysis. Precision depends on the repeatability of sampling and analytical protocols. It can be assured or improved by replication of sample analyses including blanks, field/lab standards and reference standards.

B. Sample Representativeness

An important goal of any monitoring program is collection of data that is truly representative of conditions at the site. The term representativeness applies to chemical and hydrogeologic data collected via wells, borings, piezometers, geophysical and soil gas measurements, lysimeters, and temporary sampling points. It involves a recognition of the statistical variability of individual subsurface physical properties, and contaminant or major ion concentration levels, while explaining extreme values. Subsurface temporal and spatial variability are facts. Good professional practice seeks to maximize representativeness by using proven accurate and reproducible techniques to define limits on the distribution of measurements collected at a site. However, measures of representativeness are dynamic and are controlled by evolving site characterization and monitoring objectives. An evolutionary site characterization model, as shown in Figure 1, provides a systematic approach to the goal of consistent data collection.

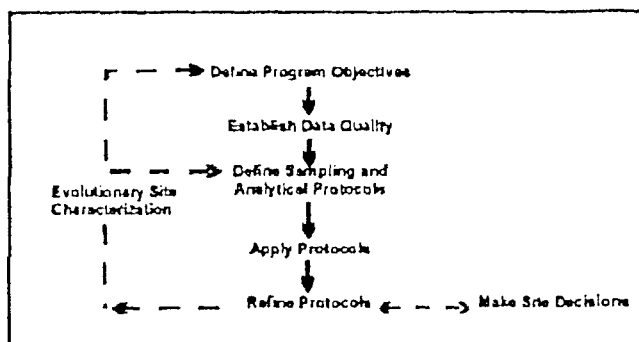


Figure 1. Evolutionary Site Characterization Model

The model emphasizes a recognition of the causes of the

variability (e.g., use of inappropriate technology such as using bailers to purge wells; imprecise or operator dependent methods) and the need to control avoidable errors.

1) Questions of scale

A sampling plan designed to collect representative samples must take into account the potential scale of changes in site conditions through space and time as well as the chemical associations and behavior of the parameters that are targeted for investigation. In subsurface systems, physical (i.e. aquifer) and chemical properties over time or space are not statistically independent. In fact samples taken in close proximity (i.e. within distances of a few yards) or within short time periods (i.e. more frequently than monthly) are highly auto-correlated. This means that designs employing high-sampling frequency (e.g. monthly) or dense spatial monitoring designs run the risk of redundant data collection and misleading inferences regarding trends in values that aren't statistically valid. In practice, contaminant detection and assessment monitoring programs rarely suffer these "over-sampling" concerns. In corrective-action evaluation programs, it is also possible that too little data may be collected over space or time. In these cases, false interpretation of the spatial extent of contamination or underestimation of temporal concentration variability may result.

2) Target Parameters

Parameter selection in monitoring program design is most often dictated by the regulatory status of the site. However, background water quality constituents, purging indicator parameters, and contaminants, all represent targets for data collection programs. The tools and procedures used in these programs should be equally rigorous and applicable to all categories of data, since all may be needed to determine or support regulatory action.

C. Sampling Point Design and Construction

Detailed site characterization is central to all decision-making purposes and the basis for this characterization resides in identification of the geologic framework and major hydro-stratigraphic units. Fundamental data for sample point location include: subsurface lithology, head-differences and background geochemical conditions. Each sampling point has a proper use or uses which should be documented at a level which is appropriate for the program's data quality objectives. Individual sampling points may not always be able to fulfill multiple monitoring objectives (e.g., detection, assessment, corrective action).

1) Compatibility with Monitoring Program and Data Quality Objectives

Specifics of sampling point location and design will be dictated by the complexity of subsurface lithology and variability in contaminant and/or geochemical conditions. It

should be noted that, regardless of the ground-water sampling approach, few sampling points (e.g. wells, drive-points, screened augers) have zones of influence in excess of a few feet. Therefore the spatial frequency of sampling points should be carefully selected and designed.

2) Flexibility of Sampling Point Design

In most cases "well-point" diameters in excess of 1 7/8 inches will permit the use of most types of submersible pumping devices for low-flow (minimal drawdown) sampling. It is suggested that "short" (e.g. less than 1.6 m) screens be incorporated into the monitoring design where possible so that we might expect comparable results from one device to another. "Short", of course, is relative to the degree of vertical water quality variability expected at a site.

3) Equilibration of Sampling Point

Time should be allowed for equilibration of the well or sampling point with the formation after installation. Placement of well or sampling points in the subsurface produces some disturbance of ambient conditions. Drilling techniques (e.g. auger, rotary, etc.) are generally considered to cause more disturbance than "direct-push" technologies. In either case, there may be a period (i.e. days to months) during which water quality near the point may be distinctly different from that in the formation. Proper development of the sampling point and adjacent formation to remove fines created during emplacement will shorten this water quality "recovery" period.

III. Definition of Low-Flow Purging and Sampling

It is generally accepted that water in the well casing is non-representative of the formation water and needs to be purged prior to collection of ground-water samples. However, the water in the screened interval may indeed be representative of the formation, depending upon well construction and site hydrogeology. Wells are purged to some extent for the following reasons: the presence of the air interface at the top of the water column resulting in an oxygen concentration gradient with depth, loss of volatiles up the water column, leaching from or sorption to the casing or filter pack, chemical changes due to clay seals or backfill, and surface infiltration.

Low-flow purging, whether using portable or dedicated systems, should be done using pump-intake located in the middle or slightly above the middle of the screened interval. Placement of the pump too close to the bottom of the well will cause increased entrainment of solids which have collected in the well over time. These particles are present as a result of well development, prior purging and sampling events, and natural colloidal transport and deposition. Therefore, placement of the pump in the middle or toward the top of the screened interval is suggested.

Placement of the pump at the top of the water column for sampling is only recommended in unconfined aquifers, screened across the water table, where this is the desired sampling point. Low-flow purging has the advantage of minimizing mixing between the overlying stagnant casing water and water within the screened interval.

A. Low-Flow Purging & Sampling

Low-flow refers to the velocity with which water enters the pump intake and that is imparted to the formation pore water in the immediate vicinity of the well screen. It does not necessarily refer to the flow rate of water discharged at the surface which can be affected by flow regulators or restrictions. Water level drawdown provides the best indication of the stress imparted by a given flow-rate for a given hydrological situation. The objective is to pump in a manner that minimizes stress (drawdown) to the system to the extent practical taking into account established site sampling objectives. Typically flow rates on the order of 0.1 - 0.5 L/min are used, however this is dependent on site-specific hydrogeology. Some extremely coarse-textured formations have been successfully sampled in this manner at flow rates to 1 L/min. The effectiveness of using low-flow purging is intimately linked with proper screen location, screen length, and well construction and development techniques. The reestablishment of natural flow paths in both the vertical and horizontal directions are important for correct interpretation of the data. For high resolution sampling needs, screens less than 1 m should be used. Most of the need for purging has been found to be due to passing the sampling device through the overlying casing water which causes mixing of these stagnant waters and the dynamic waters within the screened interval. Additionally, there is disturbance to suspended sediment collected in the bottom of the casing and the displacement of water out into the formation immediately adjacent to the well screen. These disturbances and impacts can be avoided using dedicated sampling equipment, which precludes the need to insert the sampling device prior to purging and sampling.

Isolation of the screened interval water from the overlying stagnant casing water may be accomplished using low-flow minimal drawdown techniques. If the pump intake is located within the screened interval most of the water pumped will be drawn in directly from the formation with little mixing of casing water or disturbance to the sampling zone. However, if the wells are not constructed and developed properly, zones other than those intended may be sampled. At some sites where geologic heterogeneities are sufficiently different within the screened interval, higher conductivity zones may be preferentially sampled. This is another reason to use shorter screened intervals, especially where high spatial resolution is a sampling objective.

B. Water Quality Indicator Parameters

It is recommended that water quality indicator

parameters be used to determine purging needs prior to sample collection in each well. Stabilization of parameters such as pH, specific conductance, dissolved oxygen, oxidation-reduction potential, temperature and turbidity should be used to determine when formation water is accessed during purging. In general the order of stabilization is pH, temperature, and specific conductance, followed by oxidation-reduction potential, dissolved oxygen and turbidity. Temperature and pH, while commonly used as purging indicators, are actually quite insensitive in distinguishing between formation water and stagnant casing water; nevertheless, these are important parameters for data interpretation purposes and should also be measured. Performance criteria for determination of stabilization should be based on water-level drawdown, pumping rate and equipment specifications for measuring indicator parameters. Instruments are available which utilize in-line flow cells to continuously measure the above parameters.

It is important to establish specific well stabilization criteria and then consistently follow the same methods thereafter, particularly with respect to drawdown, flow rate and sampling device. Generally the time or purge volume required for parameter stabilization is independent of well depth or well volumes. Dependent variables are well diameter, sampling device, hydrogeochemistry, pump flow rate, and whether the devices are used in a portable or dedicated manner. If the sampling device is already in place (ie, dedicated sampling systems), then the time and purge volume needed for stabilization is much shorter. Other advantages of dedicated equipment include less purge water for waste disposal, much less decontamination of equipment, less time spent in preparation of sampling as well as time in the field, and more consistency in the sampling approach which probably will translate into less variability in sampling results. The use of dedicated equipment is strongly recommended at wells which will undergo routine sampling over time.

If parameter stabilization criteria are too stringent, then minor oscillations in indicator parameters may cause purging operations to become unnecessarily protracted. It should also be noted that turbidity is a very conservative parameter in terms of stabilization. Turbidity is always the last parameter to stabilize. Excessive purge times are invariably related to the establishment of too stringent turbidity stabilization criteria. It should be noted that natural turbidity levels in ground water may exceed 10 nephelometric turbidity units (NTU).

C. Advantages and Disadvantages of Low-Flow (Minimum Drawdown) Purging

In general, the advantages of low-flow purging include:

- samples which are representative of the 'mobile' load of contaminants present (dissolved and colloid-associated),

- minimal disturbance of the sampling point thereby minimizing sampling artifacts,
- less operator variability, greater operator control,
- reduced stress on the formation (minimal drawdown),
- less mixing of stagnant casing water with formation water,
- reduced need for filtration and therefore less time required for sampling,
- smaller purging volume which decrease waste disposal costs and sampling time,
- better sample consistency; reduced artificial sample variability

Some disadvantages of low-flow purging are:

- higher initial capital costs,
- greater set-up time in the field,
- need to transport additional equipment to and from the site,
- increased training needs,
- resistance to change on the part of sampling practitioners,
- concern that new data will indicate a "change in conditions" and trigger an "action".

IV. Low-Flow (Minimal Drawdown) Sampling Protocols

The following ground water sampling procedure has evolved over many years of experience in ground water sampling for organic and inorganic compound determinations and as such summarizes the authors (and others) experiences to date (Barcelona et al., 1984, 1994; Barcelona and Helfrich, 1986; Puls and Barcelona, 1989; Puls et. al. 1990, 1992; Puls and Powell, 1992; Puls and Paul, 1995). High-quality chemical data collection is essential in ground water monitoring and site characterization. The primary limitations to the collection of "representative" ground water samples include: mixing of the stagnant casing and "fresh" screen waters during insertion of the sampling device or ground water level measurement device; disturbance and resuspension of settled solids at the bottom of the well when using high pumping rates or raising and lowering a pump or bailer; introduction of atmospheric gases or degassing from the water during sample handling and transfer, or inappropriate use of vacuum sampling device etc.

A. Sampling Recommendations

Water samples should not be taken immediately following well development. Sufficient time should be allowed for the ground water flow regime in the vicinity of the monitoring well to stabilize and to let chemical equilibrium with the well construction materials be approached. This lag time will depend on site conditions and methods of installation but often exceeds one week.

Well purging is nearly always necessary to obtain samples of water flowing through the geologic formations in

the screened interval. Rather than using a general but arbitrary guideline of purging three casing volumes prior to sampling, it is recommended that an in-line water quality measurement device (e.g. flow-through cell) be used to establish the stabilization time for several parameters (e.g. pH, specific conductance, redox, dissolved oxygen, turbidity) on a well-specific basis. Data on pumping rate, drawdown, and volume required for parameter stabilization can be used as a guide for conducting subsequent sampling activities.

The following are recommendations to be considered before, during and after sampling:

- use low flow rates (<0.5 L/min), during both purging and sampling maintain minimal drawdown in the well;
- maximize tubing wall thickness, minimize tubing length;
- place the sampling device intake at the desired sampling point;
- minimize disturbances of the stagnant water column above the screened interval during water level measurement and sampling device insertion;
- make proper adjustments to stabilize the flow rate as soon as possible;
- monitor water quality indicators during purging;
- collect unfiltered samples to estimate contaminant loading and transport potential in the subsurface system.

B. Equipment Calibration

Prior to sampling, all sampling device and monitoring equipment should be calibrated according to manufacture's recommendations and the site Quality Assurance Project Plan (QAPP) and Field Sampling Plan (FSP). Calibration of pH should be performed with at least two buffers which bracket the expected range. Dissolved oxygen calibration must be corrected for local barometric pressure readings and elevation.

C. Water Level Measurement and Monitoring

It is recommended that a device be used which will least disturb the water surface in the casing. Well depth should be obtained from the well logs. Measuring to the bottom of the well casing will only cause resuspension of settled solids from the formation and require longer purging times for turbidity equilibration. Measure well depth after sampling is completed. The water level measurement should be taken from a permanent reference point which is surveyed in relative to ground elevation.

D. Pump Type

The use of low flow (e.g. 0.1-0.5 L/min) pumps is suggested for purging and sampling all types of analytes. All

pumps have some limitation and these should be investigated with respect to application at a particular site. Bailers are inappropriate devices for low-flow sampling.

1) General Considerations

There are no unusual requirements for ground-water sampling devices when using low-flow, minimal drawdown techniques. The major concern is that the device give consistent results and minimal disturbance of the sample across a range of "low" flow rates (i.e. < 0.5 L/min). Clearly, pumping rates that cause minimal to no drawdown in one well could easily cause "significant" drawdown in another well finished in a less transmissive formation. In this sense, the pump should not cause undue pressure or temperature changes or physical disturbance on the water sample over a reasonable sampling range. Consistency in operation is critical to meet accuracy and precision goals.

2) Advantages & Disadvantages of Sampling Devices

A variety of sampling devices are available for low-flow (minimal drawdown) purging and sampling and include peristaltic pumps, bladder pumps, electrical submersible pumps, and gas-driven pumps. Devices which lend themselves to both dedication and consistent operation at definable low-flow rates are preferred. It is desirable that the pump be easily adjustable and operate reliably at these lower flow rates. The peristaltic pump is limited to shallow applications and can cause degassing resulting in alteration of pH, alkalinity, and some volatiles loss. Gas-drive pumps should be of a type that does not allow the gas to be in direct contact with the sampled fluid.

Clearly, bailers and other "grab" type samplers are ill-suited for low-flow sampling since they will cause repeated disturbance and mixing of "stagnant" water in the casing and the "dynamic" water in the screened interval. Similarly, the use of inertial lift foot-valve type samplers may cause too much disturbance at the point of sampling. Use of these devices also tend to introduce uncontrolled and unacceptable operator variability.

Summaries of advantages and disadvantages of various sampling devices are listed in Herzog et al (1991), USEPA (1992), Parker (1994) and Thurnblad (1994).

E. Pump Installation

Dedicated sampling devices (left in the well) capable of pumping and sampling are preferred over any other type of device. Any portable sampling device should be slowly and carefully lowered to the middle of the screened interval or slightly above the middle (e.g. 1-1.5 m below the top of a 3 m screen). This is to minimize excessive mixing of the stagnant water in the casing above the screen with the screened interval zone water, and to minimize resuspension of solids which will have collected at the bottom of the well. These two disturbance effects have been shown to directly affect the time required for purging. There also appears to be a direct correlation between size of portable sampling

devices relative to the well bore and resulting purge volumes and times. The key is to minimize disturbance of water and solids in the well casing.

F. Filtration

Decisions to filter samples should be dictated by sampling objectives rather than as a "fix" for poor sampling practices, and field-filtering of certain constituents should not be the default. Consideration should be given as to what the application of field-filtration is trying to accomplish. For assessment of truly dissolved (as opposed to operationally "dissolved" [ie. samples filtered with $0.45 \mu\text{m}$ filters]) concentrations of major ions and trace metals, $0.1 \mu\text{m}$ filters are recommended although $0.45 \mu\text{m}$ filters are normally used for most regulatory programs. Alkalinity samples must also be filtered if significant particulate calcium carbonate is suspected, since this material is likely to impact alkalinity titration results (although filtration itself may alter the CO_2 composition of the sample and therefore affect the results).

Although filtration may be appropriate, filtration of a sample may cause a number of unintended changes to occur (e.g. oxidation, aeration) possibly leading to filtration-induced artifacts during sample analysis and uncertainty in the results. Some of these unintended changes may be unavoidable but the factors leading to them must be recognized. Deleterious effects can be minimized by consistent application of certain filtration guidelines. Guidelines should address selection of filter type, media, pore size, etc. in order to identify and minimize potential sources of uncertainty when filtering samples.

In-line filtration is recommended because it provides better consistency through less sample handling, and minimizes sample exposure to the atmosphere. In-line filters are available in both disposable (barrel filters) and non-disposable (in-line filter holder, flat membrane filters) formats and various filter pore sizes (0.1 - $5.0 \mu\text{m}$). Disposable filter cartridges have the advantage of greater sediment handling capacity when compared to traditional membrane filters. Filters must be pre-rinsed following manufacturer's recommendations. If there are no recommendations for rinsing, pass through a minimum of 1 L of ground water following purging and prior to sampling. Once filtration has begun, a filter cake may develop as particles larger than the pore size accumulate on the filter membrane. The result is that the effective pore diameter of the membrane is reduced and particles smaller than the stated pore size are excluded from the filtrate. Possible corrective measures include prefiltering (with larger pore size filters), minimizing particle loads to begin with, and reducing sample volume.

G. Monitoring of Water Level and Water Quality Indicator Parameters

Check water level periodically to monitor drawdown in the well as a guide to flow rate adjustment. The goal is minimal drawdown (< 0.1 m) during purging. This goal may

be difficult to achieve under some circumstances due to geologic heterogeneities within the screened interval, and may require adjustment based on site-specific conditions and personal experience. In-line water quality indicator parameters should be continuously monitored during purging. The water quality indicator parameters monitored can include pH, redox potential, conductivity, dissolved oxygen (DO) and turbidity. The last three parameters are often most sensitive. Pumping rate, drawdown, and the time or volume required to obtain stabilization of parameter readings can be used as a future guide to purge the well. Measurements should be taken every three to five minutes if the above suggested rates are used. Stabilization is achieved after all parameters have stabilized for three successive readings. In lieu of measuring all five parameters a minimum subset would include pH, conductivity, and turbidity or DO. Three successive readings should be within ± 0.1 for pH, $\pm 3\%$ for conductivity, ± 10 mv for redox potential, and $\pm 10\%$ for turbidity and DO. Stabilized purge indicator parameter trends are generally obvious and follow either an exponential or asymptotic change to stable values during purging. Dissolved oxygen and turbidity usually require the longest time for stabilization. The above stabilization guidelines are provided for rough estimates based on experience.

H. Sampling, Sample Containers, Preservation and Decontamination

Upon parameter stabilization, sampling can be initiated. If an in-line device is used to monitor water quality parameters, it should be disconnected or bypassed during sample collection. Sampling flow rate may remain at established purge rate or may be adjusted slightly to minimize aeration, bubble formation, turbulent filling of sample bottles, or loss of volatiles due to extended residence time in tubing. Typically, flow rates less than 0.5 L/min are appropriate. The same device should be used for sampling as was used for purging. Sampling should occur in a progression from least to most contaminated well if this is known. Generally, volatile (e.g. solvents and fuel constituents) and gas sensitive (e.g. Fe^{2+} , CH_4 , $\text{H}_2\text{S}/\text{HS}^-$, alkalinity) parameters should be sampled first. The sequence in which samples for most inorganic parameters are collected is immaterial unless filtered (dissolved) samples are desired. Filtering should be done last and in-line filters should be used as discussed above. During both well purging and sampling, proper protective clothing and equipment must be used based upon the type and level of contaminants present.

The appropriate sample container will be prepared in advance of actual sample collection for the analytes of interest and include sample preservative where necessary. Water samples should be collected directly into this container from the pump tubing.

Immediately after a sample bottle has been filled, it must be preserved as specified in the site Quality Assurance Project Plan (QAPP). Sample preservation requirements are

based on the analyses being performed (use site QAPP, Field Safety Plan [FSP], USEPA, 1992 RCRA guidance document or EPA SW-846). It may be advisable to add preservatives to sample bottles in a controlled setting prior to entering the field in order to reduce the chances of improperly preserving sample bottles or introducing field contaminants into a sample bottle while adding the preservatives.

The preservatives should be transferred from the chemical bottle to the sample container using a disposable polyethylene pipet and the disposable pipet should be used only once and then discarded.

After a sample container has been filled with ground water, a Teflon (or tin)-lined cap is screwed on tightly to prevent the container from leaking. A sample label is filled out as specified in the Field Sampling Plan (FSP). The samples should be stored inverted at 4°C.

Specific decontamination protocols for sampling devices are dependent to some extent on the type of device used and the type of contaminants encountered. Refer to the site QAPP and FSP for specific requirements.

I. Blanks

The following blanks should be collected:

- (1) field blank: one field blank should be collected from each source water (distilled/deionized water) used for sampling equipment decontamination or for assisting well development procedures.
- (2) equipment blank: one equipment blank should be taken prior to the commencement of field work, from each set of sampling equipment to be used for that day. Refer to site QAPP or FSP for specific requirements.
- (3) trip blank: a trip blank is required to accompany each volatile sample shipment. These blanks are prepared in the laboratory by filling a 40-mL volatile organic analysis (VOA) bottle with distilled/deionized water.

V. Low-Permeability Formations and Fractured Rock

The overall sampling program goals or sampling objectives will drive how the sampling points are located, installed, and choice of sampling device. Likewise, site-specific hydrogeologic factors will affect these decisions. Sites with very low permeability formations or fractures causing discrete flow channels may require a unique monitoring approach. Unlike water supply wells, wells installed for ground-water quality assessment and restoration programs are often installed in low water-yielding settings

(e.g. clays, silts). Alternative types of sampling points and sampling methods are often needed in these types of environments, because low-permeability settings may require extremely low-flow purging (<0.1 L/min) and may be technology-limited. Where devices are not readily available to pump at such low flow rates, the primary consideration is to avoid dewatering of the well screen. This may require repeated recovery of the water during purging while leaving the pump in place within the well screen.

Use of low-flow techniques may be impractical in these settings, depending upon the water recharge rates. The sampler and the end-user of data collected from such wells need to understand the limitations of the data collected, i.e. a strong potential for underestimation of actual contaminant concentrations for volatile organics, potential false negatives for filtered metals and potential false positives for unfiltered metals. It is suggested that comparisons be made between samples recovered using low-flow purging techniques and samples recovered using passive sampling techniques (i.e. two sets of samples). Passive sample collection would essentially entail acquisition of the sample with no or very little purging using a dedicated sampling system installed within the screened interval or a passive sample collection device.

A. Low-Permeability Formations (<0.1 L/min recharge)

1. Low-Flow Purging and Sampling with Pumps

- a. "portable or non-dedicated mode" - Lower the pump (one capable of pumping at <0.1 L/min) to mid-screen or slightly above and set in place for minimum of 48 hours (to lessen purge volume requirements). After 48 hours, use procedures listed in Part IV above regarding monitoring water quality parameters for stabilization, etc., but do not dewater the screen. If excessive drawdown and slow recovery is a problem, then alternate approaches such as those listed below may be better.
- b. "dedicated mode" - Set the pump as above at least a week prior to sampling; that is, operate in a dedicated pump mode. With this approach significant reductions in purge volume should be realized. Water quality parameters should stabilize quite rapidly due to less disturbance of the sampling zone.

2. Passive Sample Collection

Passive sampling collection requires insertion of the device into the screened interval for a sufficient time period to allow flow and sample equilibration before extraction for analysis. Conceptually, the extraction of water from low yielding formations seems more akin to the collection of water from the unsaturated zone and passive sampling

techniques may be more appropriate in terms of obtaining "representative" samples. Satisfying usual sample volume requirements is typically a problem with this approach and some latitude will be needed on the part of regulatory entities to achieve sampling objectives.

B. Fractured Rock

In fractured rock formations, a low-flow to zero purging approach using pumps in conjunction with packers to isolate the sampling zone in the borehole is suggested. Passive multi-layer sampling devices may also provide the most "representative" samples. It is imperative in these settings to identify flow paths or water-producing fractures prior to sampling using tools such as borehole flowmeters and/or other geophysical tools.

After identification of water-bearing fractures, install packer(s) and pump assembly for sample collection using low-flow sampling in "dedicated mode" or use a passive sampling device which can isolate the identified water bearing fractures.

VI. Documentation

The usual practices for documenting the sampling event should be used for low-flow purging and sampling techniques. This should include, at a minimum: information on the conduct of purging operations (flow-rate, drawdown, water-quality parameter values, volumes extracted and times for measurements), field instrument calibration data, water sampling forms and chain of custody forms. See Figures 2 and 3 and "Ground Water Sampling Workshop -- A Workshop Summary" (USEPA, 1995) for example forms and other documentation suggestions and information. This information coupled with laboratory analytical data and validation data are needed to judge the "useability" of the sampling data.

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Project _____ Site _____ Well No. _____ Date _____
Well Depth _____ Screen Length _____ Well Diameter _____ Casing Type _____
Sampling Device _____ Tubing type _____ Water Level _____
Measuring Point _____ Other Infor _____

Sampling Personnel _____

[illegible]

Information: 2 in = 517 ml/ft, 4 in = 2470 ml/ft; $\text{Vol}_{\text{cyl}} = \pi r^2 h$, $\text{Vol}_{\text{sphere}} = 4/3 \pi r^3$

Project _____ Site _____ Well No. _____ Date _____
Well Depth _____ Screen Length _____ Well Diameter _____ Casing Type _____
Sampling Device _____ Tubing type _____ Water Level _____
Measuring Point _____ Other Infor _____

Sampling Personnel _____

[illegible]

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft: $\text{Vol}_{\text{cyl}} = \pi r^2 h$, $\text{Vol}_{\text{sphere}} = 4/3 \pi r^3$

APPENDIX E

ANALYTICAL DATA TABLES

FORMER BUILDING 67

SOIL BORING SAMPLE RESULTS

Table 1
Fort Des Moines, Des Moines, Iowa
Former Building 67
1996 Soil Boring
Analytical Data, Volatile Organics

All Sample IDs begin with "B67-"		Sample Location:		SB96-0102	SB96-0106	SB96-0110	SB96-0206	SB96-0206-01	SB96-0208	SB96-0210	SB96-0306		
		Sample Depth (feet):		2'	6'	10'	6'	6'	8'	10'	6'	EPA Region 3	EPA Region 3
		Date Sampled:		22-Jul-96	22-Jul-96	22-Jul-96	18-Jul-96	18-Jul-96	18-Jul-96	18-Jul-96	24-Jul-96	RBC, Soil Ingestion	BTAG Soil Screening
	ANALYTE	UNITS	Reporting limit										
1.	Chloromethane	µg/kg	10	u	u	u	u	u	u	u	u	440000	none
2.	Vinyl chloride	µg/kg	10	u	u	u	u	u	u	u	u	3000	300000
3.	Bromomethane	µg/kg	10	u	u	u	u	u	u	u	u	2900000	none
4.	Chloroethane	µg/kg	10	u	u	u	u	u	u	u	u	2000000	none
5.	Acetone	µg/kg	50	u	u	u	u	u	u	u	u	200000000	none
6.	1,1-Dichloroethene	µg/kg	5.0	u	u	u	u	u	u	u	u	9500	none
7.	Carbon disulfide	µg/kg	5.0	u	u	u	u	u	u	u	u	200000000	none
8.	Methylene chloride	µg/kg	5.0	u	u	u	3.5JB	u	3.4JB	4.7JB	27	760000	300000
9.	trans-1,2-Dichloroethene	µg/kg	5.0	u	u	u	u	u	u	u	u	41000000	300000
10.	1,1-Dichloroethane	µg/kg	5.0	u	u	u	u	u	u	u	u	200000000	300000
11.	cis-1,2-Dichloroethene	µg/kg	5.0	u	u	u	u	u	u	u	u	20000000	300000
12.	Chloroform	µg/kg	5.0	u	u	u	u	u	u	u	u	940000	300000
13.	1,2-Dichloroethane	µg/kg	5.0	u	u	u	u	u	u	u	u	63000	870
14.	Vinyl acetate	µg/kg	50	u	u	u	u	u	u	u	u	2000000000	none
15.	2-Butanone	µg/kg	50	u	u	u	u	u	u	u	u	1200000000	none
16.	1,1,1-Trichloroethane	µg/kg	5.0	u	u	u	u	u	u	u	u	41000000	300000
17.	Carbon tetrachloride	µg/kg	5.0	u	u	u	u	u	u	u	u	44000	300000
18.	Benzene	µg/kg	5.0	u	u	u	u	u	u	u	u	200000	100000
19.	Trichloroethene	µg/kg	5.0	u	u	u	u	u	u	u	u	520000	300000
20.	1,2-Dichloropropane	µg/kg	5.0	u	u	u	u	u	u	u	u	84000	300000
21.	Bromodichloromethane	µg/kg	5.0	u	u	u	u	u	u	u	u	92000	none
22.	cis-1,3-Dichloropropene	µg/kg	5.0	u	u	u	u	u	u	u	u	32000	none
23.	trans-1,3-Dichloropropene	µg/kg	5.0	u	u	u	u	u	u	u	u	32000	none
24.	1,1,2-Trichloroethane	µg/kg	5.0	u	u	u	u	u	u	u	u	100000	300000
25.	Dibromochloromethane	µg/kg	5.0	u	u	u	u	u	u	u	u	68000	none
26.	Bromoform	µg/kg	5.0	u	u	u	u	u	u	u	u	720000	none
27.	2-Hexanone	µg/kg	25	u	u	u	u	u	u	u	u	82000000	none
28.	Toluene	µg/kg	5.0	u	u	u	u	u	u	u	u	410000000	100000
29.	4-Methyl-2-pentanone	µg/kg	25	u	u	u	u	u	u	u	u	160000000	none
30.	Tetrachloroethene	µg/kg	5.0	u	u	u	u	u	u	u	u	110000	300000
31.	Chlorobenzene	µg/kg	5.0	u	u	u	u	u	u	u	u	41000000	100000
32.	Ethylbenzene	µg/kg	5.0	u	u	u	u	u	u	u	u	200000000	100000
33.	Xylenes (total)	µg/kg	5.0	u	u	u	u	u	u	u	u	4100000000	100000
34.	Styrene	µg/kg	5.0	u	u	u	u	u	u	u	u	410000000	100000
35.	1,1,2,2-Tetrachloroethane	µg/kg	5.0	u	u	u	u	u	u	u	u	29000	300000
u: undetected below the value given in the "Reporting Limit" column													
J: estimated concentration													
B: present in blank													
none: no screening value exists for this compound													

Table 1
Fort Des Moines, Des Moines, Iowa
Former Building 67
1996 Soil Boring
Analytical Data, Volatile Organics

All Sample IDs begin with "B67-"		Sample Location:		SB96-0308	SB96-0308-01	SB96-0310	SB96-0404	SB96-0406	SB96-0410	SB96-0502	SB96-0504	SB96-0510		
		Sample Depth (feet):		8'	8'	10'	4'	6'	10'	2'	4'	10'	EPA Region 3	EPA Region 3
			Date Sampled:	24-Jul-96	24-Jul-96	24-Jul-96	23-Jul-96	23-Jul-96	23-Jul-96	23-Jul-96	23-Jul-96	23-Jul-96	RBC, Soil Ingestion	BTAG Soil Screening
	ANALYTE	UNITS	Reporting limit											
1.	Chloromethane	µg/kg	10	u	u	u	u	u	u	u	u	u	440000	none
2.	Vinyl chloride	µg/kg	10	u	u	u	u	u	u	u	u	u	3000	300000
3.	Bromomethane	µg/kg	10	u	u	u	u	u	u	u	u	u	2900000	none
4.	Chloroethane	µg/kg	10	u	u	u	u	u	u	u	u	u	2000000	none
5.	Acetone	µg/kg	50	u	u	u	u	u	u	u	u	u	200000000	none
6.	1,1-Dichloroethene	µg/kg	5.0	u	u	u	u	u	u	u	u	u	9500	none
7.	Carbon disulfide	µg/kg	5.0	u	u	u	u	u	u	u	u	u	200000000	none
8.	Methylene chloride	µg/kg	23	u		4.2JB	u	u	u	7.8	u	u	760000	300000
9.	trans-1,2-Dichloroethene	µg/kg	5.0	u	u	u	u	u	u	u	u	u	41000000	300000
10.	1,1-Dichloroethane	µg/kg	5.0	u	u	u	u	u	u	u	u	u	200000000	300000
11.	cis-1,2-Dichloroethene	µg/kg	5.0	u	u	u	u	u	u	u	u	u	20000000	300000
12.	Chloroform	µg/kg	5.0	u	u	u	u	u	u	u	u	u	940000	300000
13.	1,2-Dichloroethane	µg/kg	5.0	u	u	u	u	u	u	u	u	u	63000	870
14.	Vinyl acetate	µg/kg	50	u	u	u	u	u	u	u	u	u	2000000000	none
15.	2-Butanone	µg/kg	50	u	u	u	u	u	u	u	u	u	1200000000	none
16.	1,1,1-Trichloroethane	µg/kg	5.0	u	u	u	u	u	u	u	u	u	41000000	300000
17.	Carbon tetrachloride	µg/kg	5.0	u	u	u	u	u	u	u	u	u	44000	300000
18.	Benzene	µg/kg	5.0	u	u	u	u	u	u	u	u	u	200000	100000
19.	Trichloroethene	µg/kg	5.0	u	u	u	u	u	u	u	u	u	520000	300000
20.	1,2-Dichloropropane	µg/kg	5.0	u	u	u	u	u	u	u	u	u	84000	300000
21.	Bromodichloromethane	µg/kg	5.0	u	u	u	u	u	u	u	u	u	92000	none
22.	cis-1,3-Dichloropropene	µg/kg	5.0	u	u	u	u	u	u	u	u	u	32000	none
23.	trans-1,3-Dichloropropene	µg/kg	5.0	u	u	u	u	u	u	u	u	u	32000	none
24.	1,1,2-Trichloroethane	µg/kg	5.0	u	u	u	u	u	u	u	u	u	100000	300000
25.	Dibromochloromethane	µg/kg	5.0	u	u	u	u	u	u	u	u	u	68000	none
26.	Bromoform	µg/kg	5.0	u	u	u	u	u	u	u	u	u	720000	none
27.	2-Hexanone	µg/kg	25	u	u	u	u	u	u	u	u	u	82000000	none
28.	Toluene	µg/kg	5.0	u	u	u	u	u	u	u	u	u	410000000	100000
29.	4-Methyl-2-pentanone	µg/kg	25	u	u	u	u	u	u	u	u	u	160000000	none
30.	Tetrachloroethene	µg/kg	5.0	u	u	u	u	u	u	18	8.7	18	110000	300000
31.	Chlorobenzene	µg/kg	5.0	u	u	u	u	u	u	u	u	u	41000000	100000
32.	Ethylbenzene	µg/kg	5.0	u	u	u	u	u	u	u	u	u	200000000	100000
33.	Xylenes (total)	µg/kg	5.0	u	u	u	u	u	u	u	u	u	4100000000	100000
34.	Styrene	µg/kg	5.0	u	u	u	u	u	u	u	u	u	410000000	100000
35.	1,1,2,2-Tetrachloroethane	µg/kg	5.0	u	u	u	u	u	u	u	u	u	29000	300000
	u: undetected below the value given in the "Reporting Limit" column													
	J: estimated concentration													
	B: present in blank													
	none: no screening value exists for this compound													

Table 1
Fort Des Moines, Des Moines, Iowa
Former Building 67
1996 Soil Boring
Analytical Data, Volatile Organics

All Sample IDs begin with "B67-"		Sample Location:		SB96-0810	SB96-0902	SB96-0906	SB96-0910		
		Sample Depth (feet):		10'	2'	6'	10'		EPA Region 3
			Date Sampled:	24-Jul-96	24-Jul-96	24-Jul-96	24-Jul-96	EPA Region 3	BTAG Soil Screening
	ANALYTE	UNITS	Reporting limit					RBC, Soil Ingestion	
1.	Chloromethane	µg/kg	10	u	u	u	u	440000	none
2.	Vinyl chloride	µg/kg	10	u	u	u	u	3000	300000
3.	Bromomethane	µg/kg	10	u	u	u	u	2900000	none
4.	Chloroethane	µg/kg	10	u	u	u	u	2000000	none
5.	Acetone	µg/kg	50	u	u	u	u	200000000	none
6.	1,1-Dichloroethene	µg/kg	5.0	u	u	u	u	9500	none
7.	Carbon disulfide	µg/kg	5.0	u	u	u	u	200000000	none
8.	Methylene chloride	µg/kg	5.0	40	u	u	39	760000	300000
9.	trans-1,2-Dichloroethene	µg/kg	5.0	u	u	u	u	41000000	300000
10.	1,1-Dichloroethane	µg/kg	5.0	u	u	u	u	200000000	300000
11.	cis-1,2-Dichloroethene	µg/kg	5.0	u	u	u	u	20000000	300000
12.	Chloroform	µg/kg	5.0	u	u	u	u	940000	300000
13.	1,2-Dichloroethane	µg/kg	5.0	u	u	u	u	63000	870
14.	Vinyl acetate	µg/kg	50	u	u	u	u	2000000000	none
15.	2-Butanone	µg/kg	50	u	u	u	u	1200000000	none
16.	1,1,1-Trichloroethane	µg/kg	5.0	u	u	u	u	41000000	300000
17.	Carbon tetrachloride	µg/kg	5.0	u	u	u	u	44000	300000
18.	Benzene	µg/kg	5.0	u	u	u	u	200000	100000
19.	Trichloroethene	µg/kg	5.0	u	u	u	u	520000	300000
20.	1,2-Dichloropropane	µg/kg	5.0	u	u	u	u	84000	300000
21.	Bromodichloromethane	µg/kg	5.0	u	u	u	u	92000	none
22.	cis-1,3-Dichloropropene	µg/kg	5.0	u	u	u	u	32000	none
23.	trans-1,3-Dichloropropene	µg/kg	5.0	u	u	u	u	32000	none
24.	1,1,2-Trichloroethane	µg/kg	5.0	u	u	u	u	100000	300000
25.	Dibromochloromethane	µg/kg	5.0	u	u	u	u	68000	none
26.	Bromoform	µg/kg	5.0	u	u	u	u	720000	none
27.	2-Hexanone	µg/kg	25	u	u	u	u	82000000	none
28.	Toluene	µg/kg	5.0	u	u	u	u	410000000	100000
29.	4-Methyl-2-pentanone	µg/kg	25	u	u	u	u	160000000	none
30.	Tetrachloroethene	µg/kg	5.0	u	7.9	u	u	110000	300000
31.	Chlorobenzene	µg/kg	5.0	u	u	u	u	41000000	100000
32.	Ethylbenzene	µg/kg	5.0	u	u	u	u	200000000	100000
33.	Xylenes (total)	µg/kg	5.0	u	u	u	u	4100000000	100000
34.	Styrene	µg/kg	5.0	u	u	u	u	410000000	100000
35.	1,1,2,2-Tetrachloroethane	µg/kg	5.0	u	u	u	u	29000	300000
u: undetected below the value given in the "Reporting Limit" column									
J: estimated concentration									
B: present in blank									
none: no screening value exists for this compound									

Pesticides

[illegible]

Pesticides

[illegible]

Pesticides

none: no screening value exists for this compound

Pesticides

All Sample IDs begin with "B67-"		Sample Location:		SB96-0810	SB96-0902	SB96-0906	SB96-0910		
		Sample Depth (feet):		10'	2'	6'	10'	EPA Region 3 BTAG	
		Date Sampled:		24-Jul-96	24-Jul-96	24-Jul-96	24-Jul-96	EPA Region 3	Soil Screening
	ANALYTE	UNITS	Reporting limit					RBC, Soil Ingestion, Industrial	
1.	Aldrin	µg/kg	5	u	u	u	u	340	100
2.	Alpha BHC	µg/kg	5	u	u	u	u	910	none
3.	Beta BHC	µg/kg	10	u	u	u	u	3200	none
4.	Delta BHC	µg/kg	5	u	u	u	u	none	none
5.	Lindane	µg/kg	5	u	u	u	u	4400	100
6.	Chlordane	µg/kg	5	100	u	u	u	16000	100
7.	4,4'-DDD	µg/kg	10	57	u	u	u	24000	100
8.	4,4'-DDE	µg/kg	10	13	u	u	u	17000	100
9.	4,4'-DDT	µg/kg	10	75	u	u	u	17000	100
10.	Dieldrin	µg/kg	10	87	u	u	u	360	100
11.	Alpha Endosulfan	µg/kg	5	u	u	u	u	12000000*	none
12.	Beta Endosulfan	µg/kg	10	u	u	u	u	12000000*	none
13.	Endosulfan Sulfate	µg/kg	10	u	u	u	u	none	none
14.	Endrin	µg/kg	10	u	u	u	u	610000	100
15.	Endrin Aldehyde	µg/kg	10	u	u	u	u	none	none
16.	Heptachlor	µg/kg	5	u	u	u	u	1300	none
17.	Heptachlor Epoxide	µg/kg	5	u	u	u	u	630	100
18.	Methoxychlor	µg/kg	20	u	u	u	u	10000000	100
19.	Toxaphene	µg/kg	75	u	u	u	u	5200	none
u: undetected below the value given in the "Reporting limit" column									
J: estimated concentration									
B: present in blank									
none: no screening value exists for this compound									

Herbicides

[illegible]

Herbicides

[illegible]

Herbicides

[illegible]

Metals

[illegible]

Metals

[illegible]

Metals

[illegible]

Table
Fort Des Moines, Des Moines, Iowa
Former Building 67
1996 Soil Boring Analytical Data

Metals

All Sample IDs begin with "B67-"		Sample Location:		SB96-0906	SB96-0910		
		Sample Depth (feet):		6'	10'	EPA Region	EPA Region 3 BTAG
		Date Sampled:		24-Jul-96	24-Jul-96	3 RBC, Soil Ingestion	Soil Screening
	ANALYTE	UNITS	Reporting limit				
1.	Antimony	mg/kg	0.4	u	u	820	0.48
2.	Beryllium	mg/kg	0.1	0.7	0.6	4100	0.02
3.	Cadmium	mg/kg	0.1	u	u	1000	2.5
4.	Chromium	mg/kg	0.2	21	17.7	3100000	0.02
5.	Copper	mg/kg	0.6	20.8	19.1	82000	15
6.	Lead	mg/kg	1	17	13.7	none	2
7.	Nickel	mg/kg	0.1	22.1	24.9	41000	2
8.	Silver	mg/kg	0.2	u	u	10000	0.00000098
9.	Thallium	mg/kg	0.6	u	u	140	0.001
10.	Zinc	mg/kg	0.1	68.4	71.5	610000	10
11.	Arsenic	mg/kg	0.5	10.3	9.6	3.8	32.8
12.	Selenium	mg/kg	1	u	u	10000	1.8
13.	Mercury	mg/kg	0.04	u	u	none	0.058
u: undetected below the value given in the "Reporting limit" column							
J: estimated concentration							
B: present in blank							
none: no screening value exists for this compound							

FORMER BUILDING 67

MONITORING WELL DATA

Volatile Organics

All Sample IDs begin with "B67-"		Sample Location:	GW96-0100	GW96-0101	GW96-0200		
				(duplicate of 0100)			
		Date Sampled:	20-Aug-96	20-Aug-96	20-Aug-96	Region 3 RBC	State of Iowa
ANALYTE	UNITS	Reporting limit				Tap Water	MCL
1. Chloromethane	µg/l	10	u	u	<100	1.5	none
2. Vinyl chloride	µg/l	10	u	u	<100	0.019	2
3. Bromomethane	µg/l	10	u	u	<100	8.5	none
4. Chloroethane	µg/l	10	u	u	<100	3.6	none
5. Acetone	µg/l	50	u	u	<500	3700	none
6. 1,1-Dichloroethene	µg/l	2.0	u	u	<20	0.044	7
7. Carbon disulfide	µg/l	2.0	u	u	<20	1000	none
8. Methylene chloride	µg/l	20.0	u	u	<37	4.1	none
9. trans-1,2-Dichloroethene	µg/l	2.0	u	u	<20	120	100
10. 1,1-Dichloroethane	µg/l	2.0	u	u	<20	800	none
11. cis-1,2-Dichloroethene	µg/l	2.0	u	u	<20	61	none
12. Chloroform	µg/l	50.0	u	u	<560	0.15	none
13. 1,2-Dichloroethane	µg/l	2.0	u	u	<20	0.12	none
14. Vinyl acetate	µg/l	25	u	u	<250	410	none
15. 2-Butanone	µg/l	50	u	u	<500	1900	none
16. 1,1,1-Trichloroethane	µg/l	50.0	u	u	<20	540	200
17. Carbon tetrachloride	µg/l	5.0	1.9J	2.3J	13J	0.16	5
18. Benzene	µg/l	2.0	u	u	28	0.36	5
19. Trichloroethene	µg/l	2.0	u	1.3J	<20	1.6	5
20. 1,2-Dichloropropane	µg/l	2.0	u	u	<20	0.16	5
21. Bromodichloromethane	µg/l	2.0	u	u	<20	0.17	none
22. cis-1,3-Dichloropropene	µg/l	2.0	u	u	<20	0.077*	none
23. trans-1,3-Dichloropropene	µg/l	2.0	u	u	<20	0.077*	none
24. 1,1,2-Trichloroethane	µg/l	2.0	u	u	<20	0.19	none
25. Dibromochloromethane	µg/l	2.0	u	u	<20	0.13	none
26. Bromoform	µg/l	2.0	u	u	<20	2.3	none
27. 2-Hexanone	µg/l	25	u	u	<250	1500	none
28. Toluene	µg/l	2.0	u	u	<20	750	1000
29. 4-Methyl-2-pentanone	µg/l	25	u	u	<250	2900	none
30. Tetrachloroethene	µg/l	2.0	1.2J	1.3J	1100	1.1	5
31. Chlorobenzene	µg/l	2.0	u	u	<20	35	100
32. Ethylbenzene	µg/l	2.0	u	u	<20	1300	700
33. Xylenes (total)	µg/l	2.0	u	u	<20	12000	10000
34. Styrene	µg/l	2.0	u	u	<20	1600	100
35. 1,1,2,2-Tetrachloroethane	µg/l	2.0	u	u	<20	0.053	none
u: undetected below the value given in the "Reporting Limit" column							
J: estimated concentration							
B: present in blank							
*: value for 1,3-dichloropropene							
none: no screening value exists for this compound							

Semivolatile Organics

none: no screening value exists for this compound

Semivolatile Organics

none: no screening value exists for this compound

Table
Fort Des Moines, Des Moines, Iowa
Former Building 67
1996 Monitoring Well Analytical Data

Metals

	All Sample IDs begin with "B67-"	Sample Location:		GW96-0100	GW96-0101	GW96-0200		
					(duplicate of 0100)			
		Date Sampled:		20-Aug-96	20-Aug-96	20-Aug-96	EPA Region 3 RBC	State of Iowa
	ANALYTE	UNITS	Reporting limit				Tap Water	MCL
1.	Antimony	ug/l	50	u	u	u	15	6
2.	Beryllium	ug/l	2	2	u	u	73	40
3.	Cadmium	ug/l	4	u	u	u	18	5
4.	Chromium	ug/l		255	161	214	55000	100
5.	Copper	ug/l		42	22	37	1500	1300
6.	Lead	ug/l		22	9	15	15#	none
7.	Nickel	ug/l		177	113	167	730	none
8.	Silver	ug/l	5	u	u	u	180	none
9.	Thallium	ug/l	100	u	u	u	2.6	0.5
10.	Zinc	ug/l		116	60	241	11000	none
11.	Arsenic	ug/l		17	8	16	0.045	50
12.	Selenium	ug/l		4	3	2	180	50
13.	Mercury	ug/l	0.2	u	u	u	none	none
u: undetected below the value given in the "Reporting limit" column								
J: estimated concentration								
B: present in blank								
#: lead value is an "action value", not Region 3 RBC								
none: no screening value exists for this compound								

Pesticides

All Sample IDs begin with "B67-"		Sample Location:	GW96-0100	GW96-0101 (duplicate of 0100)	GW96-0200		
		Date Sampled:	20-Aug-96	20-Aug-96	20-Aug-96	EPA Region 3	State of Iowa
	ANALYTE	UNITS	Reporting limit			RBC, Tap Water	MCL
1.	Aldrin	µg/l	0.05	u	<2	0.0039	none
2.	Alpha BHC	µg/l	0.05	u	83	0.011	none
3.	Beta BHC	µg/l	0.1	u	4	0.037	none
4.	Delta BHC	µg/l	0.05	u	5	none	none
5.	Lindane	µg/l	0.05	u	17	0.052	0.2
6.	Chlordane	µg/l	0.05	u	<2	0.19	2
7.	4,4'-DDD	µg/l	0.1	u	<3	0.28	none
8.	4,4'-DDE	µg/l	0.1	u	<3	0.2	none
9.	4,4'-DDT	µg/l	0.1	u	<3	0.2	none
10.	Dieldrin	µg/l	0.1	u	<3	0.0042	none
11.	Alpha Endosulfan	µg/l	0.1	u	<2	220 *	none
12.	Beta Endosulfan	µg/l	0.1	u	<3	220 *	none
13.	Endosulfan Sulfate	µg/l	0.1	u	<3	none	none
14.	Endrin	µg/l	0.1	u	<3	11	2
15.	Endrin Aldehyde	µg/l	0.1	u	<3	none	none
16.	Heptachlor	µg/l	0.05	u	<2	0.0023	0.4
17.	Heptachlor Epoxide	µg/l	0.1	u	<2	0.0012	0.2
18.	Methoxychlor	µg/l	0.2	u	<6	180	40
19.	Toxaphene	µg/l	0.75	u	<23	0.0096	3
*: value for endosulfan							
u: undetected below the value given in the "Reporting Limit" column							
J: estimated concentration							
B: present in blank							
none: no screening value exists for this compound							

Herbicides

[illegible]

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OLD DUMP SITE

SEDIMENT AND SURFACE WATER RESULTS

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Table 1
Fort Des Moines, Des Moines, Iowa
Old Dump Site
1996 Sediment Analytical Data

Volatiles

All Sample IDs begin with "ODS-"			Sample Location:	SD96-01-01	SD96-02-01	SD96-02-01-01	SD96-03-01	SD96-04-01	SD96-05-01	SD96-06-01
			Sample Depth (feet):	1	1	1	1	1	1	1
			Date Sampled:	16-Jul-96	16-Jul-96	16-Jul-96	16-Jul-96	16-Jul-96	16-Jul-96	16-Jul-96
	ANALYTE	UNITS	Reporting limit							
1.	Chloromethane	µg/kg	10	u	u	u	u	u	u	u
2.	Vinyl chloride	µg/kg	10	u	u	u	u	u	u	u
3.	Bromomethane	µg/kg	10	u	u	u	u	u	u	u
4.	Chloroethane	µg/kg	10	u	u	u	u	u	u	u
5.	Acetone	µg/kg	50	u	u	44J	u	u	u	u
6.	1,1-Dichloroethene	µg/kg	5.0	u	u	u	u	u	u	u
7.	Carbon disulfide	µg/kg	5.0	u	u	u	u	u	u	u
8.	Methylene chloride	µg/kg	5.0	u	4.0 JB	u	u	u	u	4.0 JB
9.	<i>trans</i> -1,2-Dichloroethene	µg/kg	5.0	u	u	u	u	u	u	u
10.	1,1-Dichloroethane	µg/kg	5.0	u	u	u	u	u	u	u
11.	<i>cis</i> -1,2-Dichloroethene	µg/kg	5.0	u	u	u	u	u	u	u
12.	Chloroform	µg/kg	5.0	u	u	u	u	u	u	u
13.	1,2-Dichloroethane	µg/kg	5.0	u	u	u	u	u	u	u
14.	Vinyl acetate	µg/kg	50	u	u	u	u	u	u	u
15.	2-Butanone	µg/kg	50	u	u	u	u	u	u	u
16.	1,1,1-Trichloroethane	µg/kg	5.0	u	u	u	u	u	u	u
17.	Carbon tetrachloride	µg/kg	5.0	u	u	u	u	u	u	u
18.	Benzene	µg/kg	5.0	u	u	u	u	u	u	u
19.	Trichloroethene	µg/kg	5.0	u	u	u	u	u	u	u
20.	1,2-Dichloropropane	µg/kg	5.0	u	u	u	u	u	u	u
21.	Bromodichloromethane	µg/kg	5.0	u	u	u	u	u	u	u
22.	<i>cis</i> -1,3-Dichloropropene	µg/kg	5.0	u	u	u	u	u	u	u
23.	<i>trans</i> -1,3-Dichloropropene	µg/kg	5.0	u	u	u	u	u	u	u
24.	1,1,2-Trichloroethane	µg/kg	5.0	u	u	u	u	u	u	u
25.	Dibromochloromethane	µg/kg	5.0	u	u	u	u	u	u	u
26.	Bromoform	µg/kg	5.0	u	u	u	u	u	u	u
27.	2-Hexanone	µg/kg	25	u	u	u	u	u	u	u
28.	Toluene	µg/kg	5.0	u	u	u	u	u	u	u
29.	4-Methyl-2-pentanone	µg/kg	25	u	u	u	u	u	u	u
30.	Tetrachloroethene	µg/kg	5.0	u	u	u	u	u	u	u
31.	Chlorobenzene	µg/kg	5.0	u	u	u	u	u	u	u
32.	Ethylbenzene	µg/kg	5.0	u	u	u	u	u	u	u
33.	Xylenes (total)	µg/kg	5.0	u	u	u	u	u	u	u
35.	Styrene	µg/kg	5.0	u	u	u	u	u	u	u
36.	1,1,2,2-Tetrachloroethane	µg/kg	5.0	u	u	u	u	u	u	u
u: undetected below the value given in the "Reporting Limit" column										
J: estimated concentration										
B: present in blank										
No sediment screening values for volatiles.										

Semivolatile Organics

U: undetected below the value given in the "reporting limit" column			
J: estimated concentration	J-: biased low		
B: present in blank			
D: derived from 1:4 dilution of extract.			

Semivolatile Organics

ER-M: Effect Range - Median

Pesticides

[illegible]

Table 1

Volatiles

All Sample IDs begin with "ODS-"		Sample Location:		SW96-01-01	SW96-01-01-01	
		Sample Depth (feet):		ug/l	ug/l	ug/l
		Date Sampled:		16-Jul-96	16-Jul-96	Eco Concerns
	ANALYTE	UNITS	Reporting limit			Region 4
1.	Chloromethane	µg/kg	10	<10	<10	
2.	Vinyl chloride	µg/kg	10	<10	<10	
3.	Bromomethane	µg/kg	10	<10	<10	
4.	Chloroethane	µg/kg	10	<2	<2	
5.	Acetone	µg/kg	50	<50	<50	
6.	1,1-Dichloroethene	µg/kg	5.0	<2.0	<2.0	303
7.	Carbon disulfide	µg/kg	5.0	<2.0	<2.0	
8.	Methylene chloride	µg/kg	5.0	<2.0	<2.0	1930
9.	trans-1,2-Dichloroethene	µg/kg	5.0	u	u	1350
10.	1,1-Dichloroethane	µg/kg	5.0	u	u	
11.	cis-1,2-Dichloroethene	µg/kg	5.0	u	u	
12.	Chloroform	µg/kg	5.0	u	u	289
13.	1,2-Dichloroethane	µg/kg	5.0	u	u	2000
14.	Vinyl acetate	µg/kg	50	u	u	
15.	2-Butanone	µg/kg	50	u	u	
16.	1,1,1-Trichloroethane	µg/kg	5.0	u	u	528
17.	Carbon tetrachloride	µg/kg	5.0	u	u	352
18.	Benzene	µg/kg	5.0	u	u	53
19.	Trichloroethene	µg/kg	5.0	u	u	
20.	1,2-Dichloropropane	µg/kg	5.0	u	u	525
21.	Bromodichloromethane	µg/kg	5.0	u	u	
22.	cis-1,3-Dichloropropene	µg/kg	5.0	u	u	24.4
23.	trans-1,3-Dichloropropene	µg/kg	5.0	u	u	24.4
24.	1,1,2-Trichloroethane	µg/kg	5.0	u	u	940
25.	Dibromochloromethane	µg/kg	5.0	u	u	
26.	Bromoform	µg/kg	5.0	u	u	293
27.	2-Hexanone	µg/kg	25	u	u	
28.	Toluene	µg/kg	5.0	u	u	175
29.	4-Methyl-2-pentanone	µg/kg	25	u	u	
30.	Tetrachloroethene	µg/kg	5.0	u	u	84
31.	Chlorobenzene	µg/kg	5.0	u	u	195
32.	Ethylbenzene	µg/kg	5.0	u	u	453
33.	Xylenes (total)	µg/kg	5.0	u	u	
35.	Styrene	µg/kg	5.0	u	u	
36.	1,1,2,2-Tetrachloroethane	µg/kg	5.0	u	u	240
u: undetected below the value given in the "Reporting Limit" column						
J: estimated concentration						
B: present in blank						
No sediment values for volatiles						

Table 1
Fort Des Moines, Des Moines, Iowa
Old Dump Site
1996 Surface Water Analytical Data

Semivolatile Organics

All Sample IDs begin with "ODS-"		Sample Location:		SW96-01-01	SW96-01-01-01	ppb	ppb
		Sample Depth (feet):		ug/l	ug/l		Eco concerns
		Date Sampled:		16-Jul-96	16-Jul-96		
	ANALYTE	UNITS	Reporting limit			ER-L/ER-M	Region 4
1.	Phenol	µg/kg	510	<5	<5		
2.	Bis(2-chloroethyl)ether	µg/kg	510	<5	<5		
3.	2-Chlorophenol	µg/kg	510	<5	<5		
4.	1,3-Dichlorobenzene	µg/kg	510	<5	<5		
5.	1,4-Dichlorobenzene	µg/kg	510	<5	<5		
6.	Benzyl Alcohol	µg/kg	5100	<50	<50		
7.	1,2-Dichlorobenzene	µg/kg	510	<5	<5		
8.	2-Methylphenol	µg/kg	510	<5	<5		
9.	2,2'-Oxybis(1-chloropropane)	µg/kg	510	<5	<5		
10.	4-Methylphenol	µg/kg	510	<5	<5		
11.	N-Nitroso-di-n-propylamine	µg/kg	510	<5	<5		
12.	Hexachloroethane	µg/kg	510	<5	<5		
13.	Nitrobenzene	µg/kg	510	<5	<5		
14.	Isophorone	µg/kg	510	<5	<5		
15.	2-Nitrophenol	µg/kg	1020	<10	<10		
16.	2,4-Dimethylphenol	µg/kg	1020	<10	<10		
17.	Benzoic Acid	µg/kg	5100	<50	<50		
18.	Bis (2-chloroethoxy)methane	µg/kg	510	<5	<5		
19.	2,4-Dichlorophenol	µg/kg	510	<5	<5		
20.	1,2,4-Trichlorobenzene	µg/kg	510	<5	<5		
21.	Naphthalene	µg/kg	510	<5	<5	160 / 2100	330
22.	4-Chloroaniline	µg/kg	1020	<10	<10		
23.	Hexachlorobutadiene	µg/kg	510	<5	<5		
24.	4-Chloro-3-methylphenol	µg/kg	1020	<10	<10		
25.	2-Methylnaphthalene	µg/kg	510	<5	<5	70 / 670	330
26.	Hexachlorocyclopentadiene	µg/kg	2040	<20	<20		
27.	2,4,6-Trichlorophenol	µg/kg	510	<5	<5		
28.	2,4,5-Trichlorophenol	µg/kg	510	<5	<5		
29.	2-Chloronaphthalene	µg/kg	510	<5	<5		
30.	2-Nitroaniline	µg/kg	5100	<50	<50		
31.	Dimethyl phthalate	µg/kg	510	<5	<5		
32.	Acenaphthylene	µg/kg	510	<5	<5	44 / 640	330
33.	2,6-Dinitrotoluene	µg/kg	5100	<5	<5		
34.	3-Nitroaniline	µg/kg	510	<50	<50		
35.	Acenaphthene	µg/kg	5100	<5	<5		
u: undetected below the value given in the "reporting limit" column							
J: estimated concentration		J-: biased low					
B: present in blank							
D: derived from 1:4 dilution of extract.							

Semivolatile Organics

All Sample IDs begin with "ODS-"		Sample Location:	SW96-01-01	SW96-01-01-01		
		Sample Depth (feet):	ug/l	ug/l	ppb	Eco Concerns
		Date Sampled:	16-Jul-96	16-Jul-96		Sediment
	ANALYTE	UNITS	Reporting limit		ER-L/ER-M	Region 4
36.	2,4-Dinitrophenol	µg/kg	5100	<50	<50	
37.	4-Nitrophenol	µg/kg	510	<50	<50	
38.	Dibenzofuran	µg/kg	510	<5	<5	
39.	2,4-Dinitrotoluene	µg/kg	510	<5	<5	
40.	Diethyl phthalate	µg/kg	510	<5	<5	
41.	4-Chlorophenyl phenyl ether	µg/kg	510	<5	<5	
42.	Fluorene	µg/kg	510	<5	<5	35 / 640 330
43.	4-Nitroaniline	µg/kg	5100	<50	<50	
44.	4,6-Dinitro-2-methylphenol	µg/kg	5100	<50	<50	
45.	N-Nitrosodiphenylamine	µg/kg	510	<5	<5	
46.	4-Bromophenyl phenyl ether	µg/kg	510	<5	<5	
47.	Hexachlorobenzene	µg/kg	510	<5	<5	
48.	Pentachlorophenol	µg/kg	5100	<50	<50	
49.	Phenanthrene	µg/kg	510	<5	<5	225 / 1380 330
50.	Anthracene	µg/kg	510	<5	<5	85 / 960 330
51.	Di-n-butylphthalate	µg/kg	510	<5	<5	
52.	Fluoranthene	µg/kg	510	<5	<5	600 / 3600 330
53.	Pyrene	µg/kg	510	<5	<5	350 / 2200 330
54.	Butyl benzyl phthalate	µg/kg	510	<5	<5	
55.	3,3'-Dichlorobenzidine	µg/kg	2040	<20	<20	
56.	Benzo(a)anthracene	µg/kg	510	<5	<5	230 / 1600 330
57.	Chrysene	µg/kg	510	<5	<5	400 / 2800 330
58.	Bis(2-ethylhexyl)phthalate	µg/kg	510	1 JB	1 JB	182
59.	Di-n-octyl phthalate	µg/kg	510	<5	<5	
60.	Benzo(b)fluoranthene	µg/kg	510	<5	<5	
61.	Benzo(k)fluoranthene	µg/kg	510	<5	<5	
62.	Benzo(a)pyrene	µg/kg	510	<5	<5	400 / 2500 330
63.	Indeno(1,2,3-cd)pyrene	µg/kg	510	<5	<5	
64.	Dibenz(a,h)anthracene	µg/kg	510	<5	<5	60 / 260 330
65.	Benzo(g,h,i)perylene	µg/kg	510	<5	<5	
u: undetected below the value given in the "Reporting limit" column						
J: estimated concentration						
B: present in blank						
ER-L: Effect Range - Low						
ER-M: Effect Range - Median						

Metals

All Sample IDs		Sample Location:		SW96-01-01	SW96-01-01-01	Eco Concerns	Eco Concerns
begin with "ODS-"		Sample Depth (feet):		(ug/l)	(ug/l)	ppm	(ug/l)
		Date Sampled:		16-Jul-96	16-Jul-96	Sediment	Surface Water
ANALYTE	UNITS	Reporting limit			ER-L/ER-M	Region 4	Region 4
1. Antimony	mg/kg	0.4	<50	<50	2.0 / 25	12	160
2. Beryllium	mg/kg	0.1	<2	<2			0.53
3. Cadmium	mg/kg	0.1	<4	<4	1.2 / 9.6	1	0.66
4. Chromium	mg/kg	0.2	<5	<5	81 / 370	52.3	11
5. Copper	mg/kg	0.6	<5	<5	34 / 270	18.7	6.54
6. Lead	mg/kg	1	<2	<2	46.7 / 218	30.2	1.32
7. Nickel	mg/kg	0.1	<10	<10	20.9 / 51.6	15.9	87.71
8. Silver	mg/kg	0.2	<5	<5	1 / 3.7	2	0.012
9. Thallium	mg/kg	0.6	<100	<100			4
10. Zinc	mg/kg	0.1	<4	<4	150 / 410	124	58.91
11. Arsenic	mg/kg	0.5	3	3	8.2 / 70	7.24	190
12. Selenium	mg/kg	1	<2	<2			5
13. Mercury	mg/kg	0.04	<2	<2	.15 / .71	0.13	0.012
u: undetected below the value given in the "Reporting limit" column							
J: estimated concentration							
B: present in blank							
ER-L: Effect Range - Low							
ER-M: Effect Range - Median							

Pesticides

All Sample IDs begin with "ODS-"		Sample Location:	SD96-01-01	SD96-02-01	SD96-02-01-01	SD96-03-01	SD96-04-01	SD96-05-01	SD96-06-01	SW96-01-01	SW96-01-01-01			
		Sample Depth (feet):	1	1	1	1	1	1	1	ug/l	ug/l	ppb	Eco Concerns	Eco Concerns
		Date Sampled:	16-Jul-96	16-Jul-96	16-Jul-96	16-Jul-96	16-Jul-96	16-Jul-96	16-Jul-96	16-Jul-96	16-Jul-96	Sediment	Sediment	Surface Water
	ANALYTE	UNITS	Reporting limit									ER-L/ER-M	Region 4	Region 4
1.	Aldrin	µg/kg	5	u	u	u	<100	u	u	u	<0.05	<0.05	NA	0.3
2.	Alpha BHC	µg/kg	5	u	u	u	810	u	u	u	<0.05	<0.05		
3.	Beta BHC	µg/kg	10	u	u	u	980	u	u	u	<0.1	<0.1		
4.	Delta BHC	µg/kg	5	u	u	u	250	u	u	u	<0.05	<0.05		
5.	Lindane	µg/kg	5	u	u	u	420	u	u	u	<0.05	<0.05	NA	0.08
6.	Chlordane	µg/kg	5	u	u	u	22000	u	u	u	<0.05	<0.05	5 / 6	0.0043
7.	4,4'-DDD	µg/kg	10	u	u	u	15000	51	u	70	<0.1	<0.1	3 / 350	0.064
8.	4,4'-DDE	µg/kg	10	16	u	u	7400	78	u	54	<0.1	<0.1	2.2 / 27	10.5
9.	4,4'-DDT	µg/kg	10	29	u	u	50000	36	u	45	<0.1	<0.1	1.58 / 46.1	0.001
10.	Dieldrin	µg/kg	10	38	u	u	2500	u	u	u	<0.1	<0.1	.02 / 8	0.0019
11.	Alpha Endosulfan	µg/kg	5	u	u	u	<100	u	u	u	<0.05	<0.05		0.056
12.	Beta Endosulfan	µg/kg	10	u	u	u	<200	u	u	u	<0.1	<0.1		0.056
13.	Endosulfan Sulfate	µg/kg	10	u	u	u	<200	u	u	u	<0.1	<0.1		
14.	Endrin	µg/kg	10	u	u	u	<200	u	u	u	<0.1	<0.1	0.2 / 45	0.0023
15.	Endrin Aldehyde	µg/kg	10	u	u	u	<200	u	u	u	<0.1	<0.1		
16.	Heptachlor	µg/kg	5	u	u	u	<100	u	u	u	<0.05	<0.05	NA	0.0038
17.	Heptachlor Epoxide	µg/kg	5	u	u	u	<100	u	u	u	<0.05	<0.05		0.0038
18.	Methoxychlor	µg/kg	20	u	u	u	<400	u	u	u	<0.2	<0.2		
19.	Toxaphene	µg/kg	75	u	u	u	<1500	u	u	u	<0.75	<0.75		0.0002
u: undetected below the value given in the "Reporting limit" column														
J: estimated concentration														
B: present in blank														
ER-L: Effect Range - Low														
ER-M: Effect Range - Median														

OLD DUMP SITE
SOIL SAMPLE RESULTS

Volatile Organics

	none:	no screening value exists for this compound
--	-------	---

Semivolatile Organics

u: undetected below the value given in the "reporting limit" column		
J: estimated concentration	J-: biased low	
B: present in blank	R: data rejected during data validation	
none: no screening value for this compound		

Semivolatile Organics

u: undetected below the value given in the "Reporting limit" column	
J: estimated concentration	J-: biased low
B: present in blank	
none: no screening value exists for this compound	

Pesticides

none: no screening value exists for this compound

Metals

[illegible]

APPENDIX F

CHEMICAL DATA QUALITY ASSESSMENT REPORT (CDQAR)

OMAHA DISTRICT
U.S. ARMY
CORPS OF ENGINEERS

Chemical Data Quality
Assessment Report (CDQAR)

**Former Building 67 and
Old Dump Site**

**Former Fort Des Moines
Des Moines, Iowa**

June 20, 1997

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ABBREVIATIONS

ASTM	American Standard Testing Materials
BGS	Below Ground Surface
Bldg	Building
B/N/As	Base/Neutral/Acids
BTEX	Benzene, Toluene, Ethylbenzene, Xylenes
°C	Degrees Celsius
CDQAR	Chemical Data Quality Assessment Report
CEMRO	Corps of Engineers, Omaha District
cm	Centimeter
cwm	Clear wide mouth
DCE	Dichloroethene
DDE	1,1-Dichloro-2,2-bis-(p-chlorophenyl)ethene
DDT	1,1,1-Trichloro-2,2-bis-(p-chlorophenyl)-ethane
DERP	Defense Environmental Restoration Program
DQCR	Daily Quality Control Report
Dups	Duplicates
EI/RA/AA	Environmental Investigation/Risk Assessment/Alternatives Analysis
eV	Electron volt
EPA	Environmental Protection Agency
FSP	Field Sampling Plan
Ft	Foot/Feet
FUDS	Formerly Used Defense Sites
HSA	Hollow Stem Auger
I.D.	Inner Diameter
IDW	Investigative Derived Waste
Kg	Kilogram
L	Liter
LIMS	Laboratory Information Management System
MDL	Method Detection Limit
mg/kg	Milligrams per kilogram
mg/L	Milligrams per Liter
mg	Milligram
Min	Minute
ml	Milliliters
MR Lab	Missouri River Laboratory
MS/MSD	Matrix Spike/Matrix Spike Duplicate
MSL	Mean Sea Level

N/A	Not Applicable
O.D.	Outer Diameter
PID	Photoionization Detector
PP	Priority Pollutant (Metals)
ppb	Parts per Billion (measured in water as ug/L)
ppm	Parts per Million (measured in water as mg/L); (measured in soil as mg/kg)
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
RCRA	Resource Conservation Recovery Act
SSHP	Site Safety Health Plan
SI	Site Investigation
SOP	Standard Operating Procedure
SVOCs	Semivolatile Organic Compounds
ug/L	Micrograms per Liter
U.S.	United States
USCS (soil)	Unified Soil Classification System
USACE	United States Army Corps of Engineers
USDA	United States Department of Agriculture
USGS	United States Geologic Survey
UST	Underground Storage Tank
VOCs	Volatile Organic Compounds

1 INTRODUCTION

1.1 *QUALITY CONTROL SUMMARY*

This Chemical Data Quality Assessment Report (CDQAR) describes the operations and procedures followed by USACE to conduct the Site Investigation at the Former Building 67 and Old Dump Site at Fort Des Moines. Field work was performed by USACE Omaha District personnel. Analytical services were provided by two laboratories, Missouri River Laboratory, located in Omaha, Nebraska and Continental Analytical Services, located in Salina, Kansas. Both of these laboratories are USACE validated.

Sampling at these sites was initiated as a voluntary investigation. The investigation was conducted as described in the Final Sampling and Analysis Plan for the Former Building 67 and Old Dump Site, prepared by USACE, July 1996. Results of the investigation will be presented in the SI report currently being prepared by USACE. This CDQAR includes a summary of the quality assurance (QA) and quality control (QC) procedures and an evaluation of data quality with respect to Data Quality Objectives (DQOs) established for this investigation.

1.2 *REPORT ORGANIZATION*

Section 2 of this report provides a discussion of project objectives, a description of Fort Des Moines, and background information for the two sites. Procedures employed to control and evaluate the quality of sample collection, transportation, storage, and analysis are presented in Section 3. Section 4 discusses data assessment and the results of QC evaluations. Conclusions and recommendations are presented in Section 5.

2 PROJECT DESCRIPTION

2.1 PROJECT OBJECTIVE

The objective of the site investigation was to characterize the subsurface soil and groundwater at the Former Building 67 and Old Dump Site. The analytical program for this project was designed to conform with the USACE-Omaha District General Chemistry Scope of Services (SOS) and the USACE General Geology SOS. The data collected will be used to characterize the site, prepare a SI report, and provide a risk screen for human health and the environment.

2.2 SITE LOCATION AND DESCRIPTION

Fort Des Moines (FDM) is an open post located in southern Polk County within the city limits of Des Moines, Iowa and one mile east of the Des Moines Municipal Airport. FDM is currently classified as an inactive sub-installation of Fort McCoy (Sparta, Wisconsin). Its primary mission is to provide support and shelter for the U.S. Army Reserve, and current activities are limited to reserve troop training and maintenance functions performed by six civilian employees stationed in Building 117, the vehicle maintenance shop. Most buildings at FDM are unoccupied or are used for the storage of reserve troop equipment or maintenance equipment. There is public access only from the north via Chaffee Road and Butner Street. Originally, the U.S. Army post was established on 640 acres in 1903. However, today FDM occupies 53.3 acres due to property transfers, which now are used for various commercial, residential, and recreational purposes (e.g. Blank Park Zoo).

FDM was used throughout much of its early history as a training camp. It is listed on the National Register of Historic Places because it served as the first training facility for black officers in the U.S. Army and was used as a training center for the Women's Army Auxillary Corps (WAAC) in 1942. Buildings constructed prior to 1917 are considered to be structures contributing to the overall historical nature of the installation. As a result, such buildings are afforded special protection with respect to demolition activities and the nature and extent of alterations and repairs that may be performed in and on them.

FDM became an induction center for the Army in 1941, and was used as a training center for the WAAC in 1942. The WAAC-related operations occupied a large portion of the former FDM installation that has since been excised. FDM began supporting the Army Reserve Program in 1948, and this activity has continued as the major mission of the installation up to the present time.

In 1988, the U.S. Congress passed the Base Realignment and Closure Act. Fort Des Moines was included on the list for closure and was closed in 1988.

2.2.1 Former Building 67

The most environmentally significant tenant operation during the history of FDM was the leasing of Buildings 67 and 138 to Barco Chemical Company for pesticide bagging and blending from 1950 to 1959. Building 67 was demolished in 1962 and was located on the parcel of land excessed to the City of Des Moines. Building 138 is currently boarded over and locked to minimize access. Both of these building sites are located on the western side of the current Fort Des Moines.

2.2.2 Old Dump Site

A former dump was located on property that has been excessed to the Polk County Conservation Board. This area is now utilized as a park/recreation area and there is currently a pond located near the former dump. The dump was operated from early in the history of FDM to the mid-1960s. While few details about waste types or quantities are available, the dump did receive asbestos, ash from boilers and transformers. Reportedly in the past, the sanitary sewage line overflowed into the dump area when the pump station failed.

2.3 PREVIOUS SITE INVESTIGATIONS

A series of environmental investigations have been ongoing at the FDM since 1983. In November 1983, a Pesticide Monitoring Special Study, Investigation of Possible contamination Sites was conducted at FDM and soil samples were collected at the former location of Building 67. High concentrations of lead were detected at this location. In late 1983, the U.S. Army Environmental Hygiene Agency conducted sampling within Building 138. Dust samples collected throughout Building 138 indicated high concentrations of pesticides.

Environmental Science and Engineering Inc. then conducted an Archives Search Report of FDM in January 1985, to determine the potential for on-site existence of toxic and hazardous materials and related contamination. The study included a site visit, identification of contaminants of concern, and a detailed site history.

An enhanced Preliminary Assessment was conducted by Roy F. Weston Inc. in October 1989 within the scope of the U.S. Army Installation Restoration Program (IRP). It was designed to identify environmentally significant operations (ESOs), characterize the impact of these ESOs on the surrounding environment, and provide actions that should be taken based on the ESOs.

In February 1990, the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA) tasked ICF Technology, Inc. (ICF) to develop a Work Plan for conducting an Environmental Investigation (EI) which is required for base closure to identify the presence of on-site contamination and the associated public health and environmental risks. The EI focused on a 56 acre section of FDM.

Versar Inc. was chosen to conduct the Environmental Investigation/Alternatives Analysis (EI/AA) and Phase I of the EI was conducted from December 1990 through early 1991. Activities involved sampling of USTs, asbestos sampling, radon survey, dust and residue wipe

samples of Building 138, paint sampling, monitoring well installation, and soil, sediment and surface water sampling at various sites on FDM. Versar conducted Phase II of the EI in November and December 1991. Activities involved installation and sampling of monitoring wells, Blank Park Creek samples, soil samples, and soil gas survey. Phase III of the EI included additional groundwater, surface water, soil and sediment sampling at locations that were previously sampled in Phases I and II.

2.3.1 {tc \l1 "}Former Building 67

Soil samples have been collected in and around the area formerly occupied by Building 67 (AEHA 1984). Significant levels of pesticide contaminants were not detected. However, detectable levels of some metals were found, with lead being present at the highest concentrations.

2.3.2 {tc \l1 "}Old Dump Site

Samples of soil have been taken in the landfill area and they indicate detectable levels of DDE, DDT, and chlordane as well as cadmium, chromium, lead and mercury (AEHA 1984). The detection levels are not considered high enough to present a human health concern or to impact aquatic communities. Lake sediment samples have also been taken with low levels of pesticides being detected. Metals were detected in one lake sediment sample also at low levels. These levels are not considered to be of concern.

2.4 ANALYTICAL SERVICES

Two laboratories provided the analytical services during the USACE site investigation. Missouri River Laboratory (MR Lab) provided analytical services for analysis for all analytical parameters except herbicides for the groundwater, surface water, soil, and sediment samples. MR Lab is located in Omaha, Nebraska and is a Corps of Engineers Laboratory. Continental Analytical Services, Inc. (CAS), located in Salina, KS, provided analyses of herbicides for all media for this project. CAS is fully validated by USACE. Continental's USACE validation expired December 22, 1996 and CAS has been re-validated with a new expiration date of . The full addresses of the laboratories are:

US Army Corps of Engineers
Missouri River (MR) Laboratory
420 South 18th Street
Omaha, NE 68102

Continental Analytical Services
1804 Glendale Road
Salina, Kansas

MR Laboratory reported all non-detect results as "u" with a reporting limit at the practical quantitation limit (PQL). CAS reported all non-detect results as "ND", also with a reporting limit

at the PQL. The PQL is defined by the U.S. Environmental Protection Agency (EPA) as the lowest concentration of an analyte that can reliably achieved within specified limits of precision and accuracy during routine operations. The PQL is determined by the contract laboratory taking into account impacts from sample matrix, sample preparation, and instrument limitations. The PQL represents the concentration at which the laboratory can both determine the presence of an analyte and accurately quantify the amount present. The laboratory reported detections below the PQL and higher than the MDL with a "J" laboratory qualifier, which indicates a greater degree of uncertainty associated with the quantitative result. The "J" values are considered valid and useable. Reporting limits may increase for an individual environmental sample due to high concentrations of target analytes, matrix effect, or other interferences.

2.5 DATA QUALITY OBJECTIVES

The DQOs for the Former Building 67 and the Old Dump Site are based on the objective of the investigation, which is to assess the nature and extent of any potential contamination associated with the site. At Former Building 67, the sampling conducted included sediment sampling, surface water sampling, and hand augered surface soil sampling. At the Old Dump Site, sampling conducted included soil borings and the installation of monitoring wells.

Contaminant concentrations found will be compared to EPA Region 4 Risk Based Concentrations (RBCs) and federal Maximum Contaminant Levels (MCLs). Decisions concerning the future of the two sites investigated will be based on how the contaminants found compare to these action levels.

2.5.1 Data Levels

Three levels of data were collected as defined by the EPA guidance (EPA, 1993) and summarized below.

2.5.1.1 Field Screening Data

Field Screening Data is characterized by field screening or analysis using portable instruments. Results are often not compound-specific and not quantitative, but results are available in real-time. It is the least costly of the analytical options, but the least defensible due to the greatest potential for error, and precision and accuracy limitations. This level is normally used for field investigation health and safety screening, but can also be used to identify media or samples for consideration of further analysis.

2.5.1.2 Screening Level Data

Screening level data consists of field analysis using more sophisticated portable analytical instruments than field screening data. There is a wide range in the quality of data that can be generated, depending on the use of suitable calibration standards, reference materials, sample preparation equipment, and the training of the operator. Results are available in real-time or several hours.

2.5.1.3 Definitive Level Data

Definitive level data includes all analyses performed in an analytical laboratory, located either onsite or offsite, using established analytical procedures and strict QC procedures. Applicable EPA SW-846 Test Methods for Evaluating Solid Waste will be used for the analysis, documentation, and validation. Analytical results produced are analyte specific with confirmation of analyte identity and concentration. The data is generally suitable for use throughout the site assessment, risk assessment, remedial design process and remediation efforts.

2.5.2 Data Collected – Former Building 67

The data collected at the Former Building 67 included:

2.5.2.1 Field Measurements (Field Screening Data)

A photoionization detector (PID) was used to measure organic vapors and to evaluate health and safety conditions. The PID was additionally used for headspace measurements to provide information on the relative concentrations of VOCs in soil and aid in analytical sample selection.

2.5.2.2 Soil Boring Samples (Definitive Level Data)

Soil borings were drilled to collect subsurface soil samples to further evaluate the presence and confirm the concentration of VOC contamination and other organic contamination in the vicinity of former Building 67. Soil boring locations were located based on the footprint of the former building. Analytical data from the soil borings will also be used for risk screening.

Soil samples were collected and analyzed by headspace analysis, which was conducted in the field on all of the soil samples using a PID. The results of headspace analyses are considered Level I as previously discussed. These data were used in conjunction with visual assessment, odor, and consideration of the relative mobility of target parameters in soil to select three samples from each boring for laboratory analysis.

The selected soil samples were analyzed by the offsite laboratories for target analytes using EPA SW846 methods. The analytical data quality level of these laboratory analyses is considered Definitive Level Data. These analyses provided quantitative detection and identification of target compounds which may be contained in soils at the site. Soil boring samples were analyzed for VOCs (Method 8260), Herbicides (Method 8150), Metals (Methods 6010 and 7000), and Pesticides (Method 8081).

2.5.3 Data collected - Old Dump Site

2.5.3.1 Field Measurements (Field Screening Data)

A photoionization detector (PID) was used to measure organic vapors and to evaluate health and safety conditions. The PID was additionally used for headspace measurements to provide information on the relative concentrations of VOCs in soil and aid in analytical sample selection.

2.5.3.2 Sediment Samples (Definitive Level Data)

Sediment samples were taken with a hand auger at locations within arms reach from the shore of the lake at the Old Dump Site. Sample locations were chosen to provide sufficient coverage of the lake shore. Analytical data will also be used for risk screening.

2.5.3.3 Surface Soil Samples (Definitive Level Data)

Surface soil samples were hand augered and taken from the surface (0-6") to evaluate the presence of any contamination. Surface soil locations were located based on the footprint of the former dump and were located in easily accessible locations. Analytical data from the surface soil samples will also be used for risk screening.

2.5.3.4 Surface Water Samples (Definitive Level Data)

One surface water sample was taken to evaluate the presence of any contamination. The sample was taken from near the boat dock which was easily accessible for sampling purposes. Analytical data from the surface water sample will also be used for risk screening.

All samples taken at the Old Dump Site were analyzed by the offsite laboratories for target analytes using EPA SW846 methods. The analytical data quality level of these laboratory analyses is considered Definitive Level Data. These analyses provided quantitative detection and identification of target compounds which may be contained in media at the site. Samples were analyzed for VOCs (Method 8260), Semivolatile Organics (Method 8270), Metals (Methods 6010 and 7000), and Pesticides (Method 8081).

3 FIELD QUALITY CONTROL PROCEDURES

3.1 PROJECT PLANNING

The Site Investigation was conducted as described in the Final Sampling and Analysis Plan, dated July 5, 1996. The plans were written and approved by USACE to ensure the quality of data derived from the investigation. The plans provide a discussion of the project work scope and general procedures followed for field and laboratory activities.

3.2 DOCUMENTED FIELD ACTIVITIES

This section summarizes the equipment, procedures, and methods undertaken to insure quality sample collection activities. Investigation activities and QC procedures were recorded and documented in the field using appropriate field forms. Prior to drilling and sample collection, as well as between sample locations, field equipment was decontaminated.

3.2.1 Former Building 67. Nine soil borings (B67-SB96-01 thru B67-SB96-09) were drilled to collect subsurface soil samples and to evaluate the potential presence and concentration of chemical contamination in the vicinity of the Former Building 67. Drilling occurred on July 22, 1996 through July 24, 1996 and was performed by an in-house USACE drill crew.

3.2.1.1 [COMMENT1]Borehole Drilling

Borehole drilling was performed using a Gus Pech 110C truck-mounted drill rig. An experienced USACE field geologist continuously supervised and observed all drilling operations. Soil borings were drilled using 4.25 inch inside diameter (ID) hollow stem augers. Continuous sampling of the boreholes was completed using a 3-inch OD stainless steel split-spoon for on-site visual geologic interpretation and contamination delineation. A sample was obtained approximately every 2 feet to the bottom of the boring. When the auger was advanced to the top of the desired sampling interval, the center plug was withdrawn and the decontaminated split-spoon samples was lowered into the hollow-stem auger on the end of a drill rod. The split-spoon sampler was then driven at least 24 inches using a 140 pound automatic trip hammer falling 30 inches. The number of blows it took to drive each 6-inch increment was noted by the driller and subsequently recorded by the field geologist. Once driven, the sampler and rod were withdrawn from the auger and the sampler was removed from the rods by the geologist or the helper wearing clean nitrile gloves. The split-spoon sampler was then opened by the sampler. The amount of sample recovery was measured and appropriate grab samples and/or composite samples were taken.

3.2.1.2 Soil Sampling

Soil samples were collected for geologic logging, headspace screening, and chemical analysis. The soil encountered in each boring was described and logged by the USACE field geologist. Visual/manual techniques described in American Society for Testing and Materials (ASTM) D-2487-92 and D-2488-90, and in accordance with the Unified Soil Classification System (USCS).

Soil descriptions and observations were made during the drilling and were recorded on the Hazardous and Toxic Waste (HTW) boring logs. Other observations made during drilling and the results of field headspace screening were also recorded on the HTW boring logs. After opening the sampler and logging the soil, a specified length of the collected sample was removed and composited in a stainless steel bowl, and a subsample was immediately transferred into labeled, laboratory supplied sample jars. At a minimum, soil samples were collected at 5-foot intervals to the total depth of the boring for potential chemical analysis. Soil for VOC analysis and headspace soil samples were collected directly from the sampler and placed into the appropriate sample jars. The analytical sample jars were stored in ice-filled coolers and chilled to 4 degrees Centigrade (°C), pending the results of field headspace analysis.

3.2.1.3 Headspace Analysis

As samples were collected from all intervals in a boring, the headspace analysis was conducted. The results of the headspace analysis were used in conjunction with visual assessment, odor, and consideration of the relative mobility of target parameters in the soil to select a minimum of three samples from each boring for laboratory analysis. The sample from the interval that exhibited the highest headspace reading, in addition to two others were submitted for laboratory analysis. Soil boring samples were analyzed by MR Lab with herbicide analyses being performed by CAS.

3.2.1.4 **[COMMENT2]** Monitoring Wells

Once a borehole was drilled and the samples were collected, the auger was removed. Two of the nine soil borings (SB-01 and SB-02) were then converted to monitoring wells.

3.2.1.5 Sample Handling

The sample labeling, handling, and shipping techniques used during the investigation are described in Section 3.2.9 of this report. The remaining soil samples not sent to the laboratory were emptied from their respective containers and disposed of on the ground near their respective borehole per state of Iowa IDW guidance.

3.2.2 Old Dump Site

Six hand augered soil samples, six sediment samples, and one surface water sample were collected to evaluate the potential presence and concentration of chemical contamination at the Old Dump Site. Sampling at this site occurred on July 22, 1996 and was performed by an in-house USACE sampling team.

3.2.2.1 Soil Sampling

Hand auger surface soil sampling and sediment sampling was performed by manually advancing a stainless steel hand auger from the ground surface or lake basin surface to a depth of 6 inches. The recovered sample was then extracted from the hand auger bucket. Excess sticks, rocks, water, and other debris were removed before the sample was placed into the sample container. Samples for volatile organics analysis were immediately placed in their appropriate sample containers with no headspace. The remainder of the retrieved sample was placed in a stainless

steel bowl. The sample was homogenized using stainless steel tools such that all remaining analytical composite samples were placed in sample containers and prepared for shipment to the lab. All analytical samples were then immediately placed in a cooler filled with ice to maintain sample integrity in the interim between sample collection and preparation of samples for shipment.

3.2.2.2 Surface Water Sampling

Surface water sampling was performed by dipping clean, one gallon polyethylene jugs into lake water to collect the sample. The water was then poured into the appropriate sample containers. Those containers requiring chemical preservative were pre-preserved. Samples for volatile organics analysis were collected directly into the sample containers.

3.2.3 Field Headspace Screening

Field headspace screening was performed on aliquots of the soil samples collected during the installation of soil borings to assess the potential presence of VOCs and as an aid in sample selection. Field screening utilized an organic vapor analyzer equipped with a photoionization detector (PID). The ionization potential of the lamp was 10.2 eV. Calibration of the field screening instrument equipped with PID was calibrated and recorded in the field notes. The field geologist with assistance from the field chemist performed the field screening according to the following procedures.

- Immediately upon opening the split-spoon, a representative portion of the sample was collected and placed in a clean, contaminant-free jar.
- Each jar was sealed with at least one continuous sheet of aluminum foil, using the jar lid to secure the foil onto the jar.
- The sample jar was agitated for at least fifteen seconds and then a minimum of ten minutes was allowed for the sample to adequately volatilize.
- The jar was re-shaken and then remove the jar lid was removed. The vapor sampling probe was inserted through the aluminum foil, in a manner so as not to disturb the tip. The maximum meter response was recorded in the geologist's boring log.
- The screening instrument was calibrated according to the appropriate standard span gas a minimum of twice daily and before use after a long shut down period (i.e. lunch breaks, equipment breakdowns, weather caused breaks, etc.).

3.2.4 Source Water

Source water used for steam cleaning, well drilling, borehole grouting, decontamination, and other field activities was obtained from the Blank Park Zoo. The potable water was obtained from a faucet located at the zoo maintenance facility and was transferred into a 500-gallon[COMMENT3] polyethylene drum located on the bed of the utility vehicle. The city of

Des Moines complies with the Safe Drinking Water Act by routinely analyzing the drinking water to assure contaminants of concern are below the Federal Drinking Water Standards. Therefore, no specific samples for chemical analysis were taken of this water.

3.2.5 Management of Investigation Derived Waste

Drill cuttings from soil boreholes were placed on the ground next to the borehole from which they came. All decontamination water, well development fluid, and purge water was discharged onto the ground at the sampling location. This was in accordance with the SAP and state of Iowa IDW guidance.

3.2.6 Decontamination Procedures

All stainless steel split-spoons and related sampling tools and equipment were decontaminated by a Liquinox solution wash followed by a tap water rinse, followed by a deionized water rinse. The decontamination water was disposed of on the ground at the sampling site.

Augers and down hole tools used for drilling were decontaminated between boring and well locations using pressurized hot water from a steam cleaner. Potable water supplied by the Blank Park Zoo was used for the water source. This decontamination was performed north of the Building 67 location, in an area non-impacted by the site. All rinse water was left on the ground surface.

3.2.7 [COMMENT4]Field Equipment Calibration and Preventative Maintenance

3.2.7.1 Photoionization Detector

All soil samples were screened in the field for volatile organic vapors with a Thermo Environmental Instruments PID. This instrument was calibrated daily before use with compressed isobutylene gas by the method presented in the Work Plan. The PID was checked periodically during use to ensure appropriate response to contaminants. The cap from a felt tip marker was used as a source of volatile gas to demonstrate that the instrument was responding accurately.

3.2.7.2 Water Level Measuring Device

A water level measuring device (Solinst) using electronic conductance, was used to monitor for groundwater in the monitoring wells. This instrument was checked at the beginning of each day it was used to ensure that it was responding properly. The instrument was equipped with a cable permanently marked in hundredths of a foot and, therefore, did not require additional calibration.

3.2.8 Other Documentation and Reporting of Field Activities

All field activities were thoroughly documented in indelible ink using the following forms:

- Boring Logs
- Monitoring Well Construction Diagrams

- Well Development Records
- Field Notebook
- Chain of Custody Record

Chain of Custody (COC) documentation was initiated by the field geologist and field chemist as samples were collected and selected for laboratory analysis. Sample custody was maintained from sample collection through the completion of the laboratory analysis.

3.2.9 Sample Labeling, Handling, and Shipping

Each soil, sediment, groundwater, and surface water sample was labeled with a unique identification number consisting of a site identifier, sample code, year, location, and the bottom depth of the sample in feet. The following codes were used:

<u>Site Name</u>	<u>Code</u>
Building 67	B67
Old Dump Site	ODS

Sample Matrix Code

Subsurface Soil	SB
Surface Soil	SS
Lake Sediment	SD
Groundwater	GW
Surface Water	SW

<u>Sample Type</u>	<u>Code</u>
Field Sample	00
QC Split/Dup. 01	
Trip Blank	TB
MS/MSD	MS

Bottoming depths for surface soil samples, soil boring samples, and sediment samples were rounded to the next highest whole foot. For example, a surface soil sample bottoming at 6 inches was represented as a sample bottoming at 01 feet. For duplicate/split samples, a one (01) was added after a dash at the end of the sample number. Thus, a sample number of B67-SB96-0110-01 was a QC soil sample from 10 feet in boring #1 at Building 67.

The sampling team consisted of the field geologist and field chemist. In addition, two drill crew members also performed some minor sampling. The sampling team of the field geologist and field chemist performed sample collection, sample labeling, and sample shipping. At the Old Dump Site, the driller assisted the sample team in using the hand auger for the collection of sediment and surface soil samples. Samples were collected in the appropriate sample containers provided by MR Laboratory. Sample containers and preservatives are shown on Tables 3-0 and

3-1. The sample containers were identified with waterproof labels and all writing was completed in indelible ink.

Labeled samples were placed in sealed Ziplock brand bags and packed in waterproof plastic ice chests with sufficient packaging material placed around and between the sample jars. Ice was double bagged and placed on the bottom of the cooler, and around the sample containers, and on top of the sample containers to achieve and maintain preservation at 4 degrees Celcius from the time of collection until receipt by the laboratory.

Every cooler contained a COC form, prepared in triplicate, which identified all of the sample containers, analytical requirements, time and date sampled, preservatives, and other pertinent field data. Samples were shipped daily in coordination with MR Laboratory to enable analysis within holding times. Upon receipt in the laboratory, the Sample Custodian opened the shipping containers, compared the contents with the COC record, ensured that the document control information was accurate and complete, and dated the form. A sample receipt form was also used by the laboratory to log in samples and document their integrity upon arrival. These forms are provided in the Analytical Data Package.

3.3 *FIELD QUALITY CONTROL SAMPLES*

Split samples were collected at the rate of one per every ten samples and submitted to MR Lab for analysis as specified in the sampling and analysis plan. At a minimum, trip blanks were included at one per cooler when VOC samples were collected. The results of the field QC samples and their impact on data quality are discussed in Section 5.0.

4 EVALUATION OF DATA QUALITY

The laboratory analytical data was reviewed and verified by the government and contract laboratories (MR Laboratory and Continental Analytical Services) and evaluated by the USACE project chemist for compliance with project objectives. The following section is a description of the laboratory review procedures used to ensure data quality and the project chemists' assessment of project deliverables. Data usability was determined by comparing the project DQOs against the quality of the final analytical results.

4.1 LABORATORY QUALITY CONTROL SAMPLES

This section provides a description of laboratory QC samples: duplicate control samples (DCS); method blanks, and surrogate spike samples.

4.1.1 Duplicate Control Samples

Both laboratories analyzed spike blank samples in duplicate to evaluate the precision and accuracy within an analytical batch. The nomenclature for these samples is laboratory control samples (LCS). LCS sample pairs consisted of analyte-free water which was spiked with selected target compounds. LCS results are included in the QC section of each laboratory's data package which are included in the Analytical Data Packages.

4.1.2 Method Blank Analyses

A Laboratory Method Blank is a contaminant free matrix sample (e.g. a method blank is often a volume of distilled water carried through the entire analytical scheme) that is subjected to the same analytical procedures as the field samples. The method blank is used in all analyses to verify that the determined concentrations do not reflect contamination. One method blank is performed with every batch of samples (approximately 20 samples). If consistent high blank values are observed, laboratory glassware and reagents are checked for contamination and the analysis is halted until the system is brought under control.

4.1.3 Surrogate Spike Analyses

Organic surrogate compounds are spiked into all investigative samples for pesticide, herbicide, SVOC, and VOC analyses. These surrogates are compared to QC limits to evaluate the matrix effect of each sample and monitor the overall system performance. Low surrogate recoveries are indicative of problems in instrument performance, extraction procedure, or severe matrix effects. Samples which have surrogate recoveries above the laboratory control limits typically do not demonstrate performance problems unless the recoveries are high enough to indicate double spiking of surrogate compounds or extremely low internal standard recoveries.

4.2 LABORATORY DATA VALIDATION ACTIVITIES

All analytical data generated by MR Lab and CAS were checked for completeness and evaluated

for overall quality prior to final report generation as outlined in the Quality Assurance Program Plan (QAPP) and specified in each laboratory's Standard Operating Procedures (SOPs). The validation process consisted of data generation and reduction plus three levels of documented review. Each step of the review process involved evaluation of data quality based on QC data results and the professional judgement of the reviewer(s). All reviews were documented by the reviewer's signature and the date reviewed.

The first level review was performed by the analyst who generated the raw analytical data with primary emphasis on correctness and completeness of the data set. All data were generated and reduced following method-specific SOPs. Each analyst reviewed the quality of the work based on the guidelines established in the SOP. The first review ensured that:

- Sample preparation and analysis information was correct and complete;
- The appropriate SOPs had been followed;
- QC parameters were within method control limits; and
- Documentation was complete.

The second level review was structured so that all calibration data and QC sample results were reviewed and 10 percent of the analytical results were confirmed against the bench and instrument sheets. If no problems were found with the data package, the review was considered complete. If any problems were found with the data package, an additional 10 percent of the samples were checked to the bench sheet. The process was continued for each batch until no errors were found or until each data package was reviewed in its entirety. All second level reviews were performed by a laboratory supervisor, data review specialist, or QA officer to ensure that:

- Calibration data were appropriate to the method and completely documented;
- QC samples were within established guidelines;
- Qualitative identification of sample components was correct;
- Quantitative values were calculated correctly;
- Documentation was complete and correct;
- The data were ready for final reporting; and;
- The data package was complete and ready for data archive.

An important element of the second review was the documentation of any errors identified and corrected during the review process.

Before the final report was released, a third review was performed to check each data package for completeness and to ensure that the data met the overall objectives of the project. This review was done by the laboratory Program Administrator, as stated in the QAPP. The review was performed to ensure that:

- Target analyte lists were complete as specified in the sampling and analysis plan;
- Data package checklist items were present;
- Case narratives accurately documented analytical conditions;
- All non-conformances were addressed and closed.

The Analytical Data Package (ADP) contains the following:

- Cover page, identifying project and remarks
- Summary and discussion of method QC and shipping and/or chain-of-custody errors
- Sample receipt information including copies of Cooler Receipt Forms
- Chain-of-Custody (COC) information including copies of COCs
- Analytical Test Results

As part of the review process, both contract laboratories applied data qualifiers to specific results to indicate usability and/or special analytical conditions. The following qualifiers were used to flag data:

- | | |
|---|---|
| B | The compound was also observed in the method blank. |
| J | Estimated concentration below the Reporting Limit. |
| U | The compound was not detected. |
| M | Reporting limit higher than normal due to matrix interferences. |
| D | Derived from a dilution of extract. |

All investigative and QC sample summary results have been submitted in the Analytical Data Packages. A summary of laboratory quality control issues is found on Table 4-1.

4.3 USACE PROJECT CHEMIST QUALITY EVALUATION

In addition to the internal validation conducted by MR Lab and CAS, the USACE project chemist performed data validation of the data set. This included an evaluation and validation of samples based on:

- Field Duplicate Analyses
- Trip blank analyses
- Initial sample inspection and COC documentation;
- Holding Times;
- Duplicate Control Samples;
- Method Blank Analyses
- Surrogate recoveries;
- The precision, accuracy, representativeness, completeness, and comparability (PARCC) parameters as they apply to this CDQAR; and
- An overall assessment of data compared to the project DQOs.

The results of this assessment are found in Section 5.0.

The USACE project chemist received data from the laboratories in hard copy format only. Prior to using any of the data, the above parameters were compared against project DQOs to assess any impacts on the investigative sample results. The laboratories calculated the percent recovery for spiked compounds using the following formula:

$$\text{Percent Recovery} = \frac{(C_r) * 100}{(C_s)}$$

where C_r = Spike compound result

C_s = Spike compound concentration

Duplicate pairs (field duplicates, MS/MSD, and LCS/LCSD samples) had a relative percent difference (RPD) calculated by the laboratories for the appropriate analytes using the following formulas:

$$\text{RPD} = \frac{(D_1 - D_2) * 100}{(D_1 + D_2)/2}$$

where D_1 = Larger of the two spike compound results

D_2 = Smaller of the two spike compound results

The USACE project chemist performed checks of these calculations of percent recovery and RPD for approximately 20 percent of the data. All of the calculations that had been performed by the laboratories was determined to be correct by the project chemist.

After completing these checks, sample results were translated into summary tables to facilitate evaluation of the chemical data. MR Lab and CAS's laboratory control limits for MS, MSD, surrogate, and LCS analyses are presented on Tables 4-2 through 4-11.

After evaluation of all laboratory and field QC parameters, the USACE project chemist flagged specific analytical results with the following qualifiers to indicate data usability:

- B: The analyte was detected in an associated method blank at a significant level. A result qualified with a B flag may or may not be usable.
- U: The analyte was not detected; the result is less than the method detection limit of method reporting limit. (i.e. the result is a nondetection relative to either the former or the latter limit)

- UX: The result is reported as a nondetection but the analyte may be present. There is doubt with the reported value because of QC problems. The nondetection may or may not be valid.
- J: The target analyte is positively identified but the quantitative result is an estimate and the direction of bias is unknown. The flag indicates a significant quantitative (rather than a qualitative) uncertainty exists.
- J-: The target analyte is present but the reported concentration is an estimated value that is believed to be biased low. (i.e. the actual concentration in the environmental sample believed to be higher than the reported concentration)
- J+: The target analyte is present but the reported concentration is an estimated value that is believed to be biased high. (i.e. the actual concentration in the environmental sample is believed to be lower than the reported concentration)
- R: Data is rejected due to the serious deficiencies in the ability to analyze the sample and meet quality control criteria. The presence or absence of the analyte cannot be verified. The data is not useable.
- RU: The target analyte was not detected but the nondetection is rejected. (e.g. because of QC problems or the probability of a false negative is unacceptably high)

Daily Quality Control Reports and COC documentation were compared against laboratory reports to check conformity of sample identification numbers. Analytical results were compared to daily activity logs to identify sampling procedures/activities that may have impacted data quality.

5 RESULTS OF QUALITY CONTROL ACTIVITIES AND ANALYSES

Field QC activities consisted of collecting appropriate field QC samples (field duplicates, trip blanks), daily communication between the USACE field team and MR Lab, and consistent interaction between the USACE field team and USACE-Technical Manager.

5.1.1 Field Duplicate Analyses

In accordance with the Sampling and Analysis Plan, field duplicate samples were collected at the Former Building 67 site and Old Dump Site and analyzed to evaluate sampling and laboratory precision. At Former Building 67, three soil field duplicate samples were taken. The samples were B67-SB96-0206-01, B67-SB96-0308-01, and B67-SB96-0706-01. All three field duplicate soil samples were analyzed for volatile organics, pesticides, herbicides, and TAL metals. One groundwater field duplicate sample was taken at Former Building 67, B67-GW96-0101, and it was analyzed for volatile organics, semivolatile organics, pesticides, herbicides, and TAL metals. At the Old Dump Site, one soil field duplicate, ODS-SS96-01-01, one surface water field duplicate, ODS-SW96-01-01-01, and one sediment field duplicate, ODS-SD96-02-01-01 were taken. Each sample was analyzed for volatile organics, semivolatile organics, pesticides, and TAL metals.

At the Old Dump Site, samples ODS-SS96-06-01 and ODS-SS96-06-01-01 were not in agreement for lead. Sample ODS-SS96-01 had a lead concentration of 548 mg/kg while its duplicate, ODS-SS96-06-01-01 had a lead concentration of 121 mg/kg. This discrepancy is due to inhomogeneity of the sample. However, no qualifiers were required and data usability is not impacted. For comparison purposes, the sample concentration of 548 mg/kg will be used for comparison to the imposed analyte action limits to encompass the worst case concentration scenario at the site.

There was a disagreement in two sets of field duplicates at Former Building 67. Samples B67-SB96-0706 and B67-SB96-0706-01 contained 35 $\mu\text{g/kg}$ and 89 $\mu\text{g/kg}$ tetrachloroethylene respectively. This discrepancy is not of concern since both of the detections of PCE in these samples are below the EPA Region 3 RBC of 110 $\mu\text{g/kg}$ for this compound. The data is usable and no qualifiers were required.

Field sample duplicate pair B67-GW96-0100 and B67-GW96-0101 showed a discrepancy for both lead and arsenic. Lead was detected at 22 $\mu\text{g/l}$ in B67-GW96-0100 and at 9 $\mu\text{g/l}$ in B67-GW96-0101. The 22 $\mu\text{g/l}$ lead concentration in B67-GW96-0100 will be used for comparison to action limits since it exceeds the action for lead of 15 $\mu\text{g/l}$. The arsenic detected in samples B67-GW-0100 and B67-GW-0101 was 17 $\mu\text{g/l}$ and 8 $\mu\text{g/l}$ respectively. The 17 $\mu\text{g/l}$ arsenic concentration in B67-GW-0100 will be used for comparison to action limits as it exceeds the EPA Region 3 RBC of 11 $\mu\text{g/l}$. Using the higher analyte concentrations for action level

comparisons allows the site to be evaluated in the worst case scenario. No qualifiers were required for this data and data usability is not impacted.

5.1.2 Trip Blank Analyses

Aqueous trip blanks were sent with each cooler containing aqueous samples for volatile organics analysis. One trip blank, ODS-SW96-01-TB, was sent with the surface water samples on July 17, 1996. All target volatile organic compounds were non detect in this sample. A trip blank, TB081996-A, was sent with the groundwater samples on August 19, 1996. All target volatile organic compounds were non detect in this sample also. The results of the trip blank analyses show that no artificial contamination was introduced into the aqueous samples for volatile organics analysis, that the field samples associated with these trip blanks require no qualification and that the data are usable.

[COMMENT5]

5.1.3 Documentation of Field Quality Procedures

Daily Reports and Daily Quality Control Reports (DQCRs) were completed to summarize daily investigation procedures and document QC activities. These documents were provided to the USACE-Technical Manager on a regular basis as the investigation proceeded. The DQCRs are included in Appendix A of this report. These reports summarize samples collected, environmental conditions, instrument problems, and any non-routine situations which may have impacted sample integrity. These reports were reviewed concurrently with the COC forms and the analytical results from the contractor laboratories to identify potential sampling anomalies or confirm sample identifications. The DQCR reports show collection procedures were adequate to ensure data results met project objectives.

5.2 RESULTS OF LABORATORY QC PROCEDURES AND LABORATORY QC ANALYSES

A review of laboratory QC procedures was conducted. All issues identified, and their respective solutions are summarized in Table 4-1.

5.2.1 Initial Sample Inspection and COC Documentation

MR Laboratory inspected all shipping containers and compared the contents with the appropriate COC documentation. Information from the sample check-in procedures were recorded on the Cooler Receipt Forms. This form was used to document that samples listed on the COC forms agreed with samples contained in the coolers, COC forms were filled out properly, samples were not broken, custody seals were intact, and cooler temperatures were less than or equal to 4°C. These forms are included in the Analytical Data Package.

Several shipping and chain-of-custody errors were noted for some of the sample shipments received by MR Laboratory. These errors are discussed below.

- 1) The cooler with the samples from custody paper 3867 arrived on July 18, 1996 with a broken custody seal.
- 2) Samples B67-SD96-0604 (VOA) and B67-SB96-0906 arrived with cracked sample container lids.
- 3) The samples listed on custody papers 3865 and 3867 which arrived on July 18, 1996 were not sealed in separate plastic bags.
- 4) The samples ODS-SW96-01-01-01 and ODS-SW96-01-01 arrived with bubbles in their VOA containers.
- 5) One sample was listed as ODS-SD96-01-01 on the custody papers and ODS-SD96-06-01 on the bottle label.
- 6) One shipment of samples arrived warm on July 19, 1996. MR Laboratory proceeded with the analysis under the direction of the USACE project chemist.

The impact to samples and sample validity of these shipping and chain-of-custody errors are listed below:

- 1) No impact. One of custody seals was intact.
- 2) Sample results could be biased low since the lids were cracked which could have caused loss of volatiles during shipping.
- 3) No impact.
- 4) Sample results could be biased low since volatilization occurred during shipment and caused air bubbles.
- 5) No impact. Error was corrected.
- 6) Samples results possibly biased low since volatilization was likely to occur during shipment since samples were not kept at 4°C.

5.2.2 Holding Times

Samples were shipped in coordination with MR Laboratory to ensure all analyses were completed within the required holding times. Part of the USACE chemist evaluation process included reviewing sample extraction and analysis dates to ensure holding times were met. Based on USACE's review of the laboratory data, all samples were extracted and analyzed within the required holding times.

5.2.3 Laboratory Control Samples

MR Laboratory analyzed spiked blank samples in duplicate to evaluate the precision and accuracy within an analytical batch. MR Lab's nomenclature for these samples is Laboratory Control Sample (LCS) and Laboratory Control Sample Duplicate (LCSD). LCS and LCSD results are included in the QC section of the laboratory's data package. Control limits for LCS and LCSD analytes are included in the analytical reports and summarized in Tables 4-2 through 4-11. Data for laboratory control samples are generated to provide information on the accuracy of the analytical method and on the laboratory performance.

Twenty-six compounds are used by MR Lab as spiking compounds in the LCS for the SVOC analysis. They are as follows:

phenol	2-chlorophenol	acenaphthene
1,3-dichlorobenzene	1,2-dichlorobenzene	2,4-dinitrophenol
2-nitrophenol	2,4-dimethylphenol	4-nitrophenol
bis (2-chloroethoxy)methane	2,4-dichlorophenol	2,4-dinitrotoluene
naphthalene	hexachlorobutadiene	fluorene
4-chloro-3-methylphenol	2,4,6-trichlorophenol	diethyl phthalate
4,6-dinitro-2-methylphenol	hexachlorobenzene	pyrene
pentachlorophenol	anthracene	benzo(a)anthracene
chrysene	dibenzo(a,h)anthracene	

Six compounds are used by MR Lab as spiking compounds in the LCS for pesticide analysis. They are as follows:

lindane	dieldrin	heptachlor
endrin	aldrin	4,4'-DDT

A total of seventeen LCS percent recoveries were outside of the laboratory control limits. The seventeen recoveries were contained in three different analytical batches. The three effected batches were: Batch 960822es2, SVOCs; Batch 092096A, Pesticides; and Batch 960827ew2, SVOCs. Data usability was affected for two semivolatile compounds, 1,3-dichlorobenzene and 1,2-dichlorobenzene, in one batch (960822es2). The data has been qualified as rejected, flagged as "R", and it is not usable. No other data has been rejected based on the LCS results.

5.2.4 Method Blank Analyses

Method blanks were analyzed to assess the level of background interference or contamination present in the analytical system. The following compounds were detected in method blanks during analyses of samples: methylene chloride and bis(2-ethylhexyl)phthalate. Method blank data and associated investigative sample results are presented in Table 5-3.

The following analytes were detected in the listed investigative samples and the associated method blank. The sample results were less than ten times the amount found in the method blank and the listed analytes were flagged as JB or B, in accordance with the "National Functional Guidelines".

* Methylene chloride was detected in the following samples:

ODS-SS96-01-01	B67-SB96-0206
ODS-SS96-02-01	B67-SB96-0208
ODS-SS96-04-01	B67-SB96-0210
ODS-SS96-05-01	B67-SB96-0310
ODS-SS96-06-01	B67-SB96-0802
ODS-SS96-06-01-01	

The methylene chloride detects in these samples are present due to laboratory contamination and are considered false positives. All sample detections of methylene chloride were less than 10 times that detected in the method blank.

* Bis (2-ethylhexyl)phthalate was detected in the following samples:

ODS-SS96-01-01	ODS-SS96-03-01
ODS-SS96-02-01	ODS-SS96-04-01
ODS-SS96-05-01	ODS-SS96-06-01
ODS-SS96-06-01-01	ODS-SW96-01-01

The bis(2-ethylhexyl)phthalate detect in these samples are present due to laboratory contamination and are considered false positives. All sample detections of bis (2-ethylhexyl)phthalate were less than 10 times that detected in the method blank.

5.2.5 Surrogate Recovery

Organic surrogate compounds are spiked into all investigative samples for the following analyses: pesticides, SVOCs, VOCs, and herbicides. Surrogate recoveries are compared to QC limits to evaluate the matrix effect of each sample and monitor the overall system performance. High or low surrogate recoveries indicate problems in instrument performance, extraction procedures, or severe matrix effects.

The following sample had one surrogate compound outside the listed control limits:

<u>Sample ID</u>	<u>Method</u>	<u>Analyte</u>	<u>% Surrogate Result</u>	<u>Limit</u>
B67-SB96-0706-01	Herbicides	2,4-D	189	32.7-135

The surrogate recovery is marginally greater than the upper acceptance limit and the recoveries of the remaining surrogates are in control. Detections would be flagged with "J+" and

nondetections would be flagged with "U". There were no detections in this sample.

Surrogate recoveries in all other samples were within their respective control limits and no qualifications were required.

5.2.6 MS/MSD Recovery

Additional sample aliquots were analyzed at the rate of one per batch to assess the impact of sampling matrices on target compound recovery (accuracy) and RPD (precision). Results of MS/MSD analyses are included in the Analytical Data Package.

Several MS/MSD recoveries and RPDs were outside of the control limits. These are shown on Table 5-5 and discussed in the text.

The MS and the MSD recovery for Batch 080694A, Sample ODS-SS96-01-01, were both negative. This resulted in qualification of 4,4'-DDT for this sample as "R", rejected. Since there was only one sample in the analytical batch, no other samples required qualification of "R".

For SVOC Batch 960822es2, three of the MSD (1,4-dichlorobenzene, 1,2,4-trichlorobenzene, and pentachlorophenol) and one (pentachlorophenol) of the MS spiking compounds had percent recoveries lower than the laboratory control limits. This batch also experienced LCS difficulties. Professional judgement was used in qualification based on MS and MSDs. Only one of these spiking compounds was detected in a sample analysis. 1,2,4-trichlorobenzene was detected in sample ODS-SD96-03-01. This detect was qualified as "R". All other samples in the batch were nondetect and have been qualified as "RU".

ICP Metals Batch 9608311205 has a MS and MSD recovery for antimony significantly lower than the laboratory specified control limits. The one antimony detect in a native sample, ODS-SS96-02-01 from this batch, was qualified as "J-" to indicate a potential low bias.

Batches for ICP Metals, 960906918 and 9609051448 both had low antimony MS and MSD recoveries. Matrix interference is suspected. No qualification of data is necessary.

5.2.7 Completeness of Data Packages

All data packages were reviewed by the USACE Chemist and the completeness of the data packages was confirmed. All the planned sampling activities were executed and all the laboratory analyses were performed.

5.3 PRECISION, ACCURACY, REPRESENTATIVENESS, COMPLETENESS AND COMPARABILITY (PARCC)

DQOs and their corresponding measurement indicators were specified in the Sampling and Analysis Plan. To achieve the project DQOs, specific PARCC goals are established for laboratory and field sampling procedures. These PARCC parameters are the measurement tools for determining the usability of generated data. Laboratory PARCC parameters are discussed in MR Lab's QAPP.

Precision and accuracy goals were based on knowledge of each analytical measurement system. For this CDQAR, precision was measured using the RPD between two replicated sample analyses. The precision evaluation encompassed laboratory precision (LCS samples), and combined field/laboratory precision (MS/MSD samples). The individual sample results were within the required RPD limits except as noted in Sections 5.2.3 and 5.2.5.

Accuracy was measured using the percent recovery of surrogates, MS/MSD samples, and LCS sample pairs. Spike recoveries from field samples and laboratory QC samples are compared to established control limits to determine a laboratory's ability to accurately determine both qualitative and quantitative results. The recoveries of spiked compounds are discussed in Section 5.2.6. Percent recovery data shows that the data results are acceptable for the intended data uses.

Representativeness is the degree to which the data accurately and precisely portrayed the environmental conditions being studied. For the site investigation, sampling procedures and sample locations were selected to bias samples in areas of potential places of contaminations. All sampling was conducted using known approved field procedures to minimize variability.

Completeness refers to the amount of valid data obtainable from a measurement system compared to the expected amount of data. The SAP established a completeness goal of 90 percent for laboratory QC requirements. As a part of measuring this completeness goal, the number of non-compliant surrogate, LCS and MS/MSD results were compared to the total number of data points generated for each of these QC parameters. The following results were calculated:

Out of 536 recorded surrogate results by MR lab, 1 had a percent recovery outside the established control limits, giving a completeness value of 99.9 percent.

Out of 291 recorded LCS results by MR Lab, 17 percent recoveries were outside of the established control limits, giving a completeness value of 94 percent.

Out of 232 recorded MS/MSD results by MR Lab, 16 had percent recoveries outside the established control limits, giving a completeness value of 93 percent.

The combined completeness value for laboratory QC parameters is approximately 96 percent, which is above the 90 percent goal established in the SAP. The overall precision and accuracy of each analytical method was adequate to address the primary goals of the sampling program.

The holding time project of 100 percent was met for all analyses. In addition, all data packages were reviewed by USACE and the completeness of the data packages was confirmed.

Comparability expresses the confidence with which one data set can be compared to another. Comparability objectives were met by minimizing the number of contract laboratories used, using EPA methods for all analyses, and reporting results in standardized units.

6 CONCLUSIONS

This CDQAR presents, in specific terms, the quality control practices utilized to achieve the goals of the site investigation at Fort Des Moines, Former Building 67 and the Old Dump Site. The analytical program for this project conformed with the USACE-Omaha District Chemistry General SOS and the General Geology SOS. Samples were also collected and analyzed in accordance with ASTM and EPA, and using laboratory specific QA/QC procedures. These procedures were followed to generate high quality data.

Several of the quality issues addressed in Section 1 of this report impact the usability of the data. These issues have all been addressed on Table 4-1 and will not be repeated here. Removing false negatives and positives from the data set provides a more accurate portrayal of conditions existing at the Former Building 67 and Old Dump Site and complies with the corrective action DQO goal for the project. The reviewed and qualified data are suitable for addressing the overall objective of this investigation: to evaluate the nature and vertical and lateral extent of contamination associated with these two sites. In addition, the collected data can be used to evaluate risk to human health and the environment and to make risk-based recommendations regarding whether or not further investigation or remediation is warranted. The results of this investigation will be presented in a SI report.

Table 3- 1

WATER SAMPLING SPECIFICATION

Parameter	Method #	Container ¹	Sample Preservation	Analysis
Pesticides	8081A	2-1 liter amber glass	Ice to 4°C	7 days to extraction, 14 days to analysis
Volatile Organics	8260	2 x 40 mL Glass VOA vials per well, no headspace	Ice to 4°C HCl to pH < 2	14 days
Semivolatile Organics	8270A	2 - 1 liter amber glass	Ice to 4°C	7 days to extraction, 14 days to analysis
Priority Pollutant Metals	6010A/ 7000	1- 1 liter HDPE	HNO ₃ to pH<2.	6 months, except for Hg - 28 days
Herbicides	8150A	2 - 1 liter amber glass	Ice to 4°C	7 days to extraction, 14 days to analysis

HDPE: High Density Polyethylene

¹ All containers must have teflon-lined lids except for VOC vials which shall have teflon-lined silicon septa.

Table 3- 2

SOIL SAMPLING SPECIFICATIONS

Parameter	Method #	Container*	Sample Preservation	Analysis
Pesticides	8081A	1 - 8 oz cwm	Ice to 4°C	14 days to extraction, 40 days to analysis
Volatile Organics	8260	2 - 4 oz glass jars, no headspace	Ice to 4°C	14 days
Semivolatile Organics	8270A	1 - 8 oz cwm	Ice to 4°C	14 days to extraction, 40 days to analysis
Priority Pollutant Metals	6010A/ 7000	1 - 8 oz cwm	none	6 months, except for Hg - 28 days
Herbicides	8150A	1 - 8 oz cwm	Ice to 4°C	14 days to extraction, 40 days to analysis

HDPE: High Density Polyethylene

cwm: clear wide mouth glass

* : All containers must have teflon-lined lids except for VOC vials which shall have teflon-lined silicon septa.

Table 4- 1

Laboratory Quality Control Issues
Fort Des Moines, Former Building 67 and Old Dump Site
Site Investigation

Lab Batch ID	Sample Ids	Issue	Resolution
960822es2, SVOCs	ODS-SD96-01-01, ODS-SD96-03-01, ODS-SD96-04-01, ODS-SS96-01-01, ODS-SS96-02-01, ODS-SS96-03-01, ODS-SS96-04-01	<p>Eleven of the twenty-six spiking compounds for the LCS for the SVOC analysis were recovered below the lower laboratory control limit.</p> <p>a. The LCS recovery for 1,2-dichlorobenzene and 1,3-dichlorobenzene, were grossly out of control, and had a 0% recovery each.</p> <p>b. The LCS recoveries for naphthalene and hexachlorobutadiene were grossly less than the lower acceptance limit.</p> <p>c. The LCS recovery for seven of the LCS spiking compounds (2-chlorophenol, 2-nitrophenol, 2,4-dimethylphenol, bis(2-chloroethoxy)methane, 2,4-dichlorophenol, acenaphthene, and fluorene) were marginally lower than the acceptance limit.</p> <p>d. Three of the MS/MSD spiking compounds (1,4-dichlorobenzene, 1,2,4-trichlorobenzene, and pentachlorophenol) had percent recoveries lower than the laboratory control recovery limits.</p>	<p>a. There were no detects of 1,3-dichlorobenzene or 1,2-dichlorobenzene for any of the samples in this batch. Non detects were qualified with a "RU" flag.</p> <p>b. The detections of naphthalene and hexachlorobutadiene for all samples in this batch were qualified as "R", rejected if the action level was not exceeded or qualified as "J-" if the action level was exceeded. Nondetections were qualified with a "RU" flag.</p> <p>c. The detections for these seven compounds were qualified with "J-" flag and the nondetections were qualified with the "UX" flag.</p> <p>d. Nondetects have been qualified as "RU". One detect of 1,2,4-trichlorobenzene in sample ODS-SD96-03-01 has been qualified as "R" based on professional judgement.</p>

960822es2, SVOCs (cont.)	ODS-SD96-01-01, ODS-SD96-03-01, ODS-SD96-04-01, ODS-SS96-01-01, ODS-SS96-02-01, ODS-SS96-03-01, ODS-SS96-04-01	e. The RPDs for all three of the above MS/MSD compounds were greater than the laboratory RPD limit.	e. No further qualification required.
092096A Pesticides	B67-GW96-0100, B67-GW96-0200, B67-GW96-0101	a. Two of the six spiking compounds (dieldrin and endrin) for the LCS were recovered above the upper control limits. b. The MS/MSD for heptachlor had a percent recovery higher than the laboratory control limit.	a. There were no detections for dieldrin or endrin; no qualification was necessary. b. The RPD for the MS/MSD was in control; no qualification necessary.
960827ew2 SVOCs	ODS-SW96-01-01, ODS-SW96-01-01-01, ODS-SD96-02-01, ODS-SD96-02-01-01, ODS-SD96-05-01, ODS-SD96-06-01, ODS-SS96-05-01, ODS-SS96-06-01, ODS-SS96-06-01-01	a. Two of the twenty-six spiking compounds (hexachlorobutadiene and 4,6-dinitro-2-methylphenol) for the LCS were recovered below the lower laboratory control limit. b. The MS/MSD for 4-nitrophenol had a percent recovery higher than the laboratory control limit.	a. Nondetects were qualified with "U", detects (there were none) would have been qualified with "J+". b. The RPD for the MS/MSD was in control; no qualification necessary.
080694A Pesticides	ODS-SS96-01-01	a. The percent recovery for both the MS and MSD were below the lower laboratory control limit for 4,4'-DDT(both were negative).	a. The 4,4'-DDT result for sample ODS-SS96-01-01 has been qualified as rejected. No other samples required qualification since this was the only sample analyzed in the batch.
081296A Pesticides	B67-SB96-0502, B67-SB96-0504, B67-SB96-0510, B67-SB96-0604, B67-SB96-0606, B67-SB96-0608, B67-SB96-0404, B67-SB96-0406, B67-SB96-0410, B67-SB96-0902, B67-SB96-0906, B67-SB96-0910, B67-SB96-0806, B67-SB96-0810	a. The % RPDs for two of the MS/MSD compounds, 4,4'-DDT and dieldrin, were higher than the laboratory RPD limit.	a. All other quality control parameters were in control; no qualification necessary.
960724-1	B67-SB96-0206, B67-SB96-0206-01,	a. The % RPD for 2,4-D was 2% higher than the	a. All other quality control parameters were

Herbicides	B67-SB96-0208, B67-SB96-0210	laboratory control limit of 40%.	in control; no qualification necessary.
960730-1 Herbicides	B67-SB96-0102, B67-SB96-0106, B67-SB96-0110, B67-SB96-0702, B67-SB96-0706, B67-SB96-0706-01, B67-SB96-0708, B67-SB96-0502, B67-SB96-0504, B67-SB96-0510	a. The % RPD for three of the MS/MSD compounds (2,4-D, 2,4,5-T, 2,4,5-TP) were higher than the laboratory RPD limit. b. The surrogate recovery in sample B67-SB96- 0706-01, was higher than the upper control limit for 2,4-D.	a. All other quality control parameters were in control; no qualification necessary. b. The result for 2,4-D for this sample was non-detect. No qualification was necessary.
9608311205 Metals	ODS-SS96-01-01, ODS-SS96-02-01, ODS-SS96-03-01, ODS-SS96-04-01, ODS-SS96-05-01, ODS-SS96-06-01, ODS-SS96-06-01-01, ODS-SD96-01- 01, ODS-SD96-02-01, ODS-SD96-03- 01, ODS-SD96-04-01, ODS-SD96-05- 01, ODS-SD96-06-01, ODS-SD96-02- 01-01, B67-SB96-0206	a. The MS and MSD recoveries for antimony were lower than the laboratory control limit. b. The MSD recovery for zinc was one percent lower than the laboratory control limit.	a. Qualification of the only antimony detect in sample ODS-SS96-02-01 of "J-" to indicate a potential low bias. b. All other quality control parameters were in control; no qualification necessary.
9609050918 Metals	B67-SB96-0206-01, B67-SB96-0208, B67-SB96-0210, B67-SB96-0102, B67-SB96-0106, B67-SB96-0110, B67-SB96-0702, B67-SB96-0706, B67-SB96-0706-01, B67-SB96-0708, B67-SB96-0502	a. The MS and MSD recoveries for antimony were lower than the laboratory control limit.	a. Matrix interference suspected; no qualification necessary.
9609051448 Metals	B67-SB96-0504, B67-SB96-0510, B67-SB96-0604, B67-SB96-0606, B67-SB96-0608, B67-SB96-0404, B67-SB96-0406, B67-SB96-0410, B67-SB96-0902, B67-SB96-0906, B67-SB96-0910, B67-SB96-0806, B67-SB96-0810, B67-SB96-0306, B67-SB96-0308, B67-SB96-0308-01,	a. The MS and MSD recoveries for antimony were lower than the laboratory control limit.	a. All other quality control parameters were in control; no qualifications necessary.

B67-SB96-0310, B67-SB96-0802

Table 4-2 MR Laboratory
Analyte Percent Recovery Limits from SW-846 Method 8260 LCS

<i>Analyte</i>	<i>Method Acceptance Range@</i>	<i>Soil LCS In-House# Performance Range</i>	<i>Water LCS In-House# PerformanceRange</i>
Vinyl Chloride	1-251	4-185	71-152
1,1-Dichloroethene	1-234	57-144	86-126
Chloroform	51-138	76-120	82-112
1,2-Dichloroethane	49-155	61-133	85-118
1,1,1-Trichloroethane	52-162	65-121	77-114
Carbon Tetrachloride	70-140	61-122	75-110
Benzene	37-151	75-121	83-112
Trichloroethene	71-157	73-129	81-110
Bromodichloromethane	35-155	77-119	83-114
Dibromochloromethane	53-149	65-134	75-114
Bromoform	45-169	46-137	65-100

Table 4-2 MR Laboratory
Analyte Percent Recovery Limits from SW-846 Method 8260 LCS

1,2-Dichloroethane-d ₄ *	70-121	78-124	88-111
Toluene-d ₈ *	81-117	86-114	93-108
p-Bromofluorobenzene *	74-121	82-107	90-110

Ranges generated from data acquired from September, 1994 to July, 1996.

@ Ranges found in Method 8240A, p. 32, Table 6, Column 5; * Surrogate.

Table 4-3, MR Laboratory,
Ranges for Percent Recovery of Surrogates by Method 8260

<i>Analyte</i>	<i>Method Percent Recovery, Soils</i>	<i>Method Percent Recovery, Waters</i>	<i>MRL Performance Range, Soils</i>	<i>MRL Performance Range, Waters</i>
1,2-Dichloroethane-d ₄	70-121	76-114	78-121	88-111
Toluene-d ₈	81-117	88-110	86-113	93-108
p-Bromofluorobenzene	74-121	86-115	82-107	90-110

Table 4-4, MR Laboratory,
Percent Spike Recoveries from MS/MSD Samples from SW-846 Method 8260

<i>Analyte</i>	<i>Percent Recovery Acceptance Range, Soils</i>	<i>RPD Maximum, Soils</i>	<i>Percent Recovery Acceptance Range, Waters</i>	<i>RPD Maximum, Waters</i>
Vinyl Chloride	50-150	25	--	--
1,1-Dichloroethene	59-172	22	61-145	14
Trichloroethene	62-137	24	71-120	14
Benzene	66-172	21	76-127	11
Toluene	59-139	21	76-125	13
Chlorobenzene	60-133	21	75-130	13
Ethylbenzene	50-175	25	--	--
o-Xylene	50-150	25	--	--
1,2-Dichloroethane-d ₄	70-121	--	76-114	--
Toluene-d ₈	81-117	--	88-110	--
p-Bromofluorobenzene	74-121	--	86-115	--

ICP (Method 6010A)

SOP specified LCS and MS/MSD Percent Recovery Acceptance Limits: 80-120 (Soil and Water)
Maximum RPD: 25

Table 4-5, MR Laboratory
MS/MSD Percent Recovery Limits
from SW-846 Method 6010A

<i>Metal</i>	<i>Soil and Water Ranges Generated In-House</i>	
	<i>% Recovery</i>	<i>RPD</i>
Antimony	80-120	± 25%
Beryllium	80-120	± 25%
Cadmium	80-120	± 25%
Chromium	80-120	± 25%
Copper	80-120	± 25%
Lead	80-120	± 25%
Nickel	80-120	± 25%
Silver	80-120	± 25%
Thallium	80-120	± 25%

Table 4-5, MR Laboratory
MS/MSD Percent Recovery Limits
from SW-846 Method 6010A

Zinc	80-120	$\pm 25\%$
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GF-AA (7000 Series Methods)
 SOP specified LCS and MS/MSD Percent Recovery Acceptance Limits: 80-120 (Soil and Water)
 Maximum RPD: 20

Table 4-6, MR Laboratory
 LCS Percent Recovery Limits
 from SW-846, GFAA

<i>Metal</i>	<i>Soil and Water Range Generated In-House</i>	
	<i>% Recovery</i>	<i>RPD</i>
Antimony	80-120	± 20%
Lead	80-120	± 20%
Selenium	80-120	± 20%
Thallium	80-120	± 20%

**Table 4-7, MR Laboratory
Acceptance Ranges for Percent Recovery of Target Analytes and Surrogates
Method 8081**

Analytes	MS/MSD Soil	MS/MSD Water	Soil RPD	Water RPD	LCS Soil	LCS Water
PCB 1016	30-130	30-130	-	-	30-130	30-130
PCB 1260	30-130	30-130	-	-	30-130	30-130
Aldrin	34-132	40-120	43	22	42-122	42-122
Lindane	46-127	56-123	50	15	-	-
4,4'-DDT	23-134	38-127	50	27	25-160	25-160
Dieldrin	31-134	52-126	38	18	36-146	36-146
Endrin	42-139	56-121	45	21	30-147	30-147
Heptachlor	35-130	40-131	31	20	34-111	34-111
Surrogate	MS/MSD Soil	MS/MSD Water	Soil RPD	Water RPD	LCS Soil	LCS Water
Tetrachloro-meta-xylene	60-150	60-150	-	-	-	-

Note: For Lindane and Tetrachloro-meta-xylene, MRL uses the method specified MS/MSD acceptance limits also as the LCS acceptance limits. For PCB 1016 and PCB 1260, MRL currently uses the PCB 1254 limits. These will be updated in the revised SOP to reflect the method specified limits, 50-114% and 8-127%, respectively.

Table 4-8, MR Laboratory
Ranges for Percent Recovery of Surrogates from LCS, Method 8270

<i>Analyte</i>	<i>Method Acceptance Range, Soils</i>	<i>Method Acceptance Range, Water</i>	<i>MRL Performance Range,[#] Soils</i>	<i>MRL Performance Range,[#] Water</i>
Nitrobenzene-d ₅	23-120	35-114	23-120	48-109
2-Fluorobiphenyl	30-115	43-116	30-115	51-103
Terphenyl-d ₁₄	18-137	33-141	24-137	60-130
Phenol-d ₅	24-113	10-110	24-113	34-92
2-Fluorophenol	25-121	21-110	25-121	9-88
2,4,6-Tribromophenol	19-122	10-123	19-122	36-112

Table 4-9, MR Laboratory Ranges for Percent Recovery of Target Analytes from LCS, Method 8270				
<i>Analyte</i>	<i>Method Acceptance Range,[@] Soils</i>	<i>Method Acceptance Range,[@] Water</i>	<i>MRL Performance Range,[#] Soils</i>	<i>MRL Performance Range,[#] Water</i>
2,4,6-Trichlorophenol	52-128	52-129	52-128	52-106
2,4-Dichlorophenol	53-120	53-122	53-120	53-104
2,4-Dimethylphenol	42-108	42-109	42-108	42-109
2,4-Dinitrophenol	1-172	0-173	1-73	0-97
2-Chlorophenol	36-119	36-120	36-119	36-101
2-Nitrophenol	46-166	45-166	46-132	45-110
4,6-Dinitro-2-methylphenol	52-99	53-100	52-99	53-100
4-Chloro-3-methylphenol	40-126	41-128	40-126	41-104
4-Nitrophenol	13-105	13-106	22-105	14-106
Pentachlorophenol	38-150	38-152	38-105	38-107
Phenol	17-100	17-100	17-100	17-100

#: Performance Ranges generated from data acquired January thru September, 1996. Other target analytes are included in the LCS spike, but due to the different mixes used, there is not yet sufficient data to generate performance ranges for all the analytes spiked.

@: Acceptable ranges derived from Table 6, Column 3, P. 37, SW-846 Method 8270, Update I, July 1992.

Table 4-10, Continental Analytical Services,
Surrogate Standard Percent Recovery Limits from SW-846 Method 8150

<i>Surrogate</i>	<i>Soil Range Generated In-House</i>	<i>Water Range Generated In-House</i>
2,4-Dichlorophenylacetic acid	32.7-135	49.3-148

Table 4-11, Continental Analytical Services,
LCS Limits from SW-846 Method 8150

<i>Analyte</i>	<i>Soil Range Generated In-House</i>	<i>RPD</i>
2,4-Dichlorophenylacetic acid (2,4-D)	35-135	$\pm 40\%$
2,4,5-T	35-135	$\pm 40\%$
2,4,5-TP	40-135	$\pm 40\%$

Table 5-1

Fort Des Moines Analytical Batches
MR Laboratory

Batch 9609050918, ICP Metals
B67-SB96-0206-01
B67-SB96-0208
B67-SB96-0210
B67-SB96-0102
B67-SB96-0106
B67-SB96-0110
B67-SB96-0702
B67-SB96-0706
B67-SB96-0706-01
B67-SB96-0708
B67-SB96-0502
Method Blank
Laboratory Matrix Duplicate
Matrix Spike/Matrix Spike Duplicate
Laboratory Control Sample

Batch 9608141345A, ICP Metals
B67-SB96-0102
B67-SB96-0106
B67-SB96-0110
B67-SB96-0702
B67-SB96-0706
B67-SB96-0706-01
B67-SB96-0708
B67-SB96-0502
B67-SB96-0504
B67-SB96-0510
B67-SB96-0604

B67-SB96-0606
B67-SB96-0608
B67-SB96-.0404
B67-SB96-0406
B67-SB96-0410
B67-SB96-0902
B67-SB96-0906
B67-SB96-0910
B67-SB96-0806
B67-SB96-0810
B67-SB96-0306
Method Blank
Laboratory Matrix Duplicate
Matrix Spike/Matrix Spike Duplicate
Laboratory Control Sample

Batch 9608311205, ICP Metals
ODS-SS96-01-01
ODS-SS96-02-01
ODS-SS96-03-01
ODS-SS96-04-01
ODS-SS96-05-01
ODS-SS96-06-01
ODS-SS96-06-01-01
ODS-SS96-02-06
ODS-SD96-02-01
ODS-SD96-04-01
ODS-SD96-01-01

ODS-SD96-02-01-01

ODS-SD96-03-01

ODS-SD96-05-01

ODS-SD96-06-01

Method Blank

Laboratory Matrix Duplicate

Matrix Spike/Matrix Spike
Duplicate

Laboratory Control Sample

Batch 9609051448, ICP Metals

B67-SB96-0504

B67-SB96-0510

B67-SB96-0604

B67-SB96-0606

B67-SB96-0608

B67-SB96-0404

B67-SB96-0406

B67-SB96-0410

B67-SB96-0902

B67-SB96-0906

B67-SB96-0910

B67-SB96-0806

B67-SB96-0810

B67-SB96-0306

B67-SB96-0308

B67-SB96-0308-01

B67-SB96-0310

B67-SB96-0802

Method Blank

Laboratory Matrix Duplicate

Matrix Spike/Matrix Spike
Duplicate

Laboratory Control Sample

**Batch 9608130925, ICP
Metals**

ODS-SW96-0101

ODS-SW96-01-01-01

Method Blank

Laboratory Matrix Duplicate

Matrix Spike/Matrix Spike
Duplicate

Laboratory Control Sample

**Batch 9608291507, ICP
Metals**

B67-GW96-0200

B67-GW96-0100

B67-GW96-0101

Method Blank

Laboratory Matrix Duplicate

Matrix Spike/Matrix Spike
Duplicate

Laboratory Control Sample

**Batch 9608211248, Arsenic, Lead,
Selenium**

B67-SB96-0410

B67-SB96-0902

B67-SB96-0906

B67-SB96-0910

B67-SB96-0806

B67-SB96-0810

B67-SB96-0306

B67-SB96-0308

B67-SB96-0308-01

B67-SB96-0310

B67-SB96-0802
Method Blank
Laboratory Matrix Duplicate
Matrix Spike/Matrix Spike Duplicate
Laboratory Control Sample

**Batch 9607301535, Arsenic, Lead
Selenium**

B67-SB96-0206
B67-SB96-0206-01
B67-SB96-0208
B67-SB96-0210
B67-SB96-0702
B67-SB96-0706
B67-SB96-0706-01
B67-SB96-0708
B67-SB96-0502
B67-SB96-0504
B67-SB96-0510
B67-SB96-0604
B67-SB96-0606
B67-SB96-0608
B67-SB96-.0404
B67-SB96-0406
ODS-SD06-02-01-01

Method Blank
Laboratory Matrix Duplicate
Matrix Spike/Matrix Spike Duplicate
Laboratory Control Sample

**Batch 9607231040, Arsenic, Lead,
Selenium**

ODS-SW96-01-01
ODS-SW96-01-01-01
Method Blank

Laboratory Matrix Duplicate
Matrix Spike/Matrix Spike Duplicate
Laboratory Control Sample

Batch 9607251405, Arsenic, Selenium, Lead

B67-SB96-0102

Method Blank
Laboratory Matrix Duplicate
Matrix Spike/Matrix Spike Duplicate
Laboratory Control Sample

Batch 9608291440, Arsenic, Lead, Selenium

B67-GW96-0200
B67-GW96-0100
B67-GW96-0101
Method Blank
Matrix Spike/Matrix Spike Duplicate
Laboratory Control Sample
Laboratory Matrix Duplicate

**Batch 9607251410, Arsenic and
Selenium**

ODS-SS96-01-01
ODS-SS96-02-01
ODS-SS96-03-01
ODS-SS96-04-01
ODS-SS96-05-01
ODS-SS96-06-01
ODS-SS96-06-01-01
B67-SB96-0106
B67-SB96-0110
ODS-SD96-06-01

ODS-SD96-01-01
ODS-SD96-02-01
ODS-SD96-03-01
ODS-SD96-04-01
ODS-SD96-05-01
Method Blank
Laboratory Matrix Duplicate
Matrix Spike/Matrix Spike Duplicate
Laboratory Control Sample

Batch 9608060909A, Mercury

ODS-SW96-01-01
ODS-SW96-01-01-01
Method Blank
Laboratory Matrix Duplicate
Matrix Spike/Matrix Spike Duplicate
Laboratory Control Sample

Batch 9608141345B, Mercury

B67-SB96-0308
B67-SB96-0308-01
B67-SB96-0310
B67-SB96-0802
Method Blank
Laboratory Matrix Duplicate
Matrix Spike/Matrix Spike Duplicate
Laboratory Control Sample

Batch 9608061102B, Mercury

ODS-SS96-01-01
ODS-SS96-02-01
ODS-SS96-03-01
ODS-SS96-04-01

ODS-SS96-05-01
ODS-SS96-06-01
ODS-SS96-06-01-01
ODS-SD96-01-01
ODS-SD96-03-01
ODS-SD96-04-01
ODS-SD96-05-01
Method Blank
Laboratory Matrix Duplicate
Matrix Spike/Matrix Spike Duplicate
Laboratory Control Sample

Batch 9608091136A, Mercury

B67-SB96-0206
B67-SB96-0206-01
B67-SB96-0208
B67-SB96-0210
ODS-SD96-06-01
ODS-SD96-02-01
ODS-SD96-02-01-01
Method Blank
Laboratory Matrix Duplicate
Matrix Spike/Matrix Spike Duplicate
Laboratory Control Sample

Batch 9608281234A, Mercury

B67-GW96-0200
B67-GW96-0100
B67-GW96-0101
Method Blank
Laboratory Matrix Duplicate
Matrix Spike/Matrix Spike Duplicate

Laboratory Control Sample

Batch 960827ew2, SVOC

ODS-SW96-01-01
ODS-SW96-01-01-01
ODS-SD96-02-01
ODS-SD96-02-01-01
ODS-SD96-05-01
ODS-SD96-06-01
ODS-SS96-05-01
ODS-SS96-06-01
ODS-SS96-06-01-01

Method Blank

Laboratory Matrix Duplicate

Matrix Spike/Matrix Spike Duplicate

Laboratory Control Sample

Batch 960903ew1, SVOC

Laboratory Control Sample

Batch 960919ew1, SVOCs

B67-GW96-0200
B67-GW96-0100
B67-GW96-0101
Method Blank

Batch 960822es2, SVOC

ODS-SD96-01-01
ODS-SD96-03-01
ODS-SD96-04-01
ODS-SS96-01-01
ODS-SS96-02-01
ODS-SS96-03-01
ODS-SS96-04-01

Method Blank

Laboratory Duplicate

Matrix Spike/Matrix Spike Duplicate

Laboratory Control Sample

Batch 960724A , Pesticides

ODS-SW96-01-01

Method Blank

Laboratory Matrix Duplicate

Matrix Spike/Matrix Spike Duplicate

Batch 082096A, Pesticides

ODS-SD96-01-01

ODS-SD96-02-01

ODS-SD96-02-01-01

ODS-SD96-03-01

ODS-SD96-04-01

ODS-SD96-05-01

ODS-SD96-06-01

ODS-SS96-02-01

ODS-SS96-03-01

ODS-SS96-04-01

ODS-SS96-05-01

ODS-SS96-06-01

ODS-SS96-06-01-01

B67-SB96-0206

B67-SB96-0206-01

B67-SB96-0208

B67-SB96-0210

Method Blank

Laboratory Matrix Duplicate

Matrix Spike/Matrix Spike Duplicate

Batch 091596B, Pesticides

B67-SB96-0306

B67-SB96-0308

B67-SB96-0308-01

B67-SB96-0310

B67-SB96-0802

Batch 081296A , Pesticides

B67-SB96-0502

B67-SB96-0504

B67-SB96-0510

B67-SB96-0604

B67-SB96-0606

B67-SB96-0608

B67-SB96-0404

B67-SB96-0406

B67-SB96-0410

B67-SB96-0902

B67-SB96-0906

B67-SB96-0910

B67-SB96-0806

B67-SB96-0810

Instrument/Method Blank

Lab Matrix Duplicate

Matrix Spike/Matrix Spike Duplicate

Batch 080694A , Pesticides

ODS-SS96-01-01

Method Blank

Laboratory Matrix Duplicate

Matrix Spike/Matrix Spike Duplicate

Batch 080596A Pesticides

B67-SB96-0102

B67-SB96-0106

B67-SB96-0110

B67-SB96-0702

B67-SB96-0706

B67-SB96-0706-01

B67-SB96-07-08

Method Blank

Laboratory Matrix Duplicate

Matrix Spike/Matrix Spike Duplicate

Batch 092096A, Pesticides

B67-GW96-0100

B67-GW96-0200

B67-GW96-0101

Instrument/Method Blank

Lab Control Sample

Laboratory Matrix Duplicate

Matrix Spike/Matrix Spike Duplicate

Batch 960802 vs1, VOA

B67-SB96-0308-01

B67-SB96-0310

B67-SB96-0802

Instrument/Method Blank

Lab Control Sample

Laboratory Matrix Duplicate

Matrix Spike/Matrix Spike Duplicate

Batch 960825wl, VOA

TB081996 - A

Instrument/Method Blank

Lab Control Sample

Laboratory Matrix Duplicate

Matrix Spike/Matrix Spike Duplicate

Batch 960829 wl, VOA

B67-GW 96-0100

B67-GW 96-0200

Instrument/Method Blank

Lab Control Sample

Laboratory Matrix Duplicate

Matrix Spike/Matrix Spike Duplicate

Batch 960725 wl, VOA

ODS-SW96-01-TB

ODS-SW96-01-01

ODS-SW96-01-01-01

Instrument/Method Blank

Lab Control Sample

Laboratory Matrix Duplicate

Matrix Spike/Matrix Spike Duplicate

Batch 960731vsl, VOA

B67-SB96-0504

B67-SB96-0510

B67-SB96-0604

B67-SB96-0606

B67-SB96-0608

B67-SB96-0404

B67-SB96-0406

B67-SB96-0410
B67-SB96-0902
B67-SB96-0906
Instrument/Method Blank
Lab Control Sample
Laboratory Matrix Duplicate
Matrix Spike/Matrix Spike Duplicate

Batch 960724vsl, VOA

ODS-SS96-01-01
ODS-SS96-02-01
ODS-SS96-03-01
ODS-SS96-04-01
ODS-SS96-05-01
ODS-SD96-01-01
ODS-SD96-03-01
ODS-SD96-04-01
ODS-SW96-01-01-01
Instrument/Method Blank
Lab Control Sample
Laboratory Matrix Duplicate
Matrix Spike/Matrix Spike Duplicate

Batch 960725vsl, VOA

ODS-SS96-06-01
ODS-SS96-06-01-01
ODS-SD96-06-01
ODS-SD96-02-01
ODS-SD96-05-01
B67-SB96-0206
B67-SB96-0206-01
B67-SB96-0208
B67-SB96-0210
Instrument/Method Blank

Lab Control Sample
Laboratory Matrix Duplicate
Matrix Spike/Matrix Spike Duplicate

Batch 960726vsl, VOA

B67-SB96-0102
B67-SB96-0106
B67-SB96-0110
B67-SB96-0702
B67-SB96-0706
B67-SB96-0706-01
B67-SB96-0708
B67-SB96-0502
B67-SB96-0910
B67-SB96-0806
B67-SB96-0810
B67-SB96-0306
B67-SB96-0308
ODS-SD96-02-01-01
Instrument/Method Blank
Lab Control Sample
Laboratory Matrix Duplicate
Matrix Spike/Matrix Spike Duplicate

Batch 960730-1, Herbicides

B67-SB96-0102
B67-SB96-0106
B67-SB96-0110
B67-SB96-0702
B67-SB96-0706
B67-SB96-0706-01
B67-SB96-0708
B67-SB96-0502
B67-SB96-0504

B67-SB96-0510

Instrument/Method Blank

Lab Control Sample

Batch 960731-1 , Herbicides

B67-SB96-0604

B67-SB96-0606

B67-SB96-0608

B67-SB96-0404

B67-SB96-0406

B67-SB96-0410

B67-SB96-0902

B67-SB96-0906

B67-SB96-0910

B67-SB96-0806

Instrument/Method Blank

Matrix Spike/Matrix Spike Duplicate

Lab Control Sample

Batch 960827-1, Herbicides

B67-GW96-0200

B67-GW96-0100

B67-GW96-0101

Method Blank

Laboratory Control Sample

Matrix Spike/Matrix Spike Duplicate

Batch 960802-2, Herbicides

B67-SB96-0810

B67-SB96-0306

B67-SB96-0308

B67-SB96-0308-01

67-SB96-0310

B67-SB96-0802

Matrix Spike/Matrix Spike Duplicate

Instrument/Method Blank

Lab Control Sample

Matrix Spike/Matrix Spike Duplicate

Batch 960724-1, Herbicides

B67-SB96-0206

B67-SB96-0206-01

B67-SB96-0208
B67-SB96-0208
B67-SB96-0210

Instrument/Method Blank
Lab Control Sample
Laboratory Matrix Duplicate
Matrix Spike/Matrix Spike Duplicate

TABLE 5-2
OUT OF CONTROL LABORATORY CONTROL SAMPLE ANALYSIS
FORT DES MOINES, FORMER BUILDING 67 AND OLD DUMP SITE, SITE INVESTIGATION

Batch ID	Analyte	Result	True Value	Units	Sample Results Biased High or Low	Acceptable Range
960822es2	2-chlorophenol	160	830	ug/kg	LOW	300-1000
	1,3-dichlorobenzene	u	1700	ug/kg	LOW	280-2560
	1,2-dichlorobenzene	u	1700	ug/kg	LOW	810-1870
	2-nitrophenol	260	830	ug/kg	LOW	370-1390
	2,4-dimethylphenol	260	830	ug/kg	LOW	350-910
	bis (2-chloroethoxy)methane	360	1700	ug/kg	LOW	820-2740
	2,4-dichlorophenol	360	830	ug/kg	LOW	440-1010
	Naphthalene	140	1700	ug/kg	LOW	590-1990
	Hexachlorobutadiene	20	1700	ug/kg	LOW	630-1700
	Acenaphthene	820	1700	ug/kg	LOW	1000-2200
	Fluorene	1030	1700	ug/kg	LOW	1190-1810
092096A	Dieldrin	138	100	ug/l	HIGH	52-126
	Endrin	123	100	ug/l	HIGH	56-121
960827ew2	Hexachlorobutadiene	14	50	ug/l	LOW	18.9-51.1
	4,6-dinitro-2-methylphenol	42	125	ug/l	LOW	66.3-125.0

u = not detected above detection limit
ug/kg = micrograms per kilogram, ppb
ug/l = micrograms per liter, ppb

TABLE 5-3
METHOD BLANK DETECTIONS AND ASSOCIATED SAMPLE RESULTS
FORT DES MOINES, FORMER BUILDING 67 AND OLD DUMP SITE

Sample ID	Analyte	Sample Result	Method Blank Result	Units	Lab Flag
ODS-SS96-01-01	Methylene chloride	3.7	2.9	ug/kg	JB
ODS-SS96-02-01	Methylene chloride	5.2	2.9	ug/kg	B
ODS-SS96-04-01	Methylene chloride	4.0	2.9	ug/kg	JB
ODS-SS96-05-01	Methylene chloride	4.0	2.9	ug/kg	JB
ODS-SS96-06-01	Methylene chloride	4.9	3.0	ug/kg	JB
ODS-SS96-06-01-01	Methylene chloride	5.6	3.0	ug/kg	B
B67-SB96-0206	Methylene chloride	3.5	3.0	ug/kg	JB
B67-SB96-0208	Methylene chloride	3.4	3.0	ug/kg	JB
B67-SB96-0210	Methylene chloride	4.7	3.0	ug/kg	JB
B67-SB96-0310	Methylene chloride	4.2	5.1	ug/kg	JB
B67-SB96-0802	Methylene chloride	4.9	5.1	ug/kg	JB
ODS-SS96-01-01	bis(2-ethylhexyl)phthalate	330	90	ug/kg	B
ODS-SS96-02-01	bis(2-ethylhexyl)phthalate	200	90	ug/kg	B
ODS-SS96-03-01	bis(2-ethylhexyl)phthalate	90	90	ug/kg	JB
ODS-SS96-04-01	bis(2-ethylhexyl)phthalate	120	90	ug/kg	JB
ODS-SS96-05-01	bis(2-ethylhexyl)phthalate	70	90	ug/kg	JB
ODS-SS96-06-01	bis(2-ethylhexyl)phthalate	80	90	ug/kg	JB

ODS-SS96-06-01-01	bis(2-ethylhexyl)phthalate	80	90	ug/kg	JB
ODS-SW96-01-01	bis(2-ethylhexyl)phthalate	1	1	ug/l	JB

TABLE 5-4 NON COMPLIANT SURROGATE RECOVERIES FORT DES MOINES, FORMER BUILDING 67 AND OLD DUMP SITE				
Sample ID	Method	Analyte	% Surrogate Result	Limit
B67-SB96-0706-01	8150	2,4-D	189	32.7-135

TABLE 5-5
OUT OF CONTROL
MATRIX SPIKE AND MATRIX SPIKE DUPLICATE ANALYSIS
FORT DES MOINES, FORMER BUILDING 67 AND OLD DUMP SITE
SITE INVESTIGATION

Sample ID	Compound	Spiking Concentration	Sample Result	MS Result	MSD Result	MS Result	MSD Result	Recovery Range	Ref. Conc.	CR
Batch 960822es2	1,4-dichlorobenzene	3660/3720 ug/kg	u	1160	610	32	16	28-104	66	27
	1,2,4-trichlorobenzene	3660/3720 ug/kg	u	1730	1100	47	30	38-107	44	23
	pentachlorophenol	7310/7430 ug/kg	u	450	860	6	12	17-109	67	47
Batch 092096A	heptachlor	1.0 ug/l	u	1.52	1.43	152	143	40-131	6	20
Batch 960827ew2	4-nitrophenol	100 ug/l	u	94	86	94	86	10-80	9	50
Batch 080694A	4,4'-DDT	94 ug/kg	148 ug/kg	91	56	-2	-26	23-134	NC	50
Batch 081296A	4,4'-DDT	171/169 ug/kg	75 ug/kg	235	152	93	45	23-134	70	50
	dieldrin	171/169 ug/kg	87 ug/kg	235	178	87	54	31-134	47	38
Batch 960724-1	2,4-D	0.04 mg/kg	u	0.044	0.028	110	72	35-135	42	40
Batch 960730-1	2,4-D	0.04 mg/kg	u	0.028	0.015	70	38	35-135	59	40
	2,4,5-T	0.04 mg/kg	u	0.026	0.015	65	38	35-135	52	40
	2,4,5-TP	0.04 mg/kg	u	0.027	0.016	68	40	40-135	52	40
Batch 9608311205	antimony	200 mg/kg	u	42	46	21	23	75-125	9.1	20
	zinc	200 mg/kg	268	430	416	81	74	75-125	3.3	20
Batch 9609050918	antimony	100 mg/kg	u	39	47	39	47	75-125	18.6	20
Batch 9609051448	antimony	100 mg/kg	u	46	47	46	47	75-125	2.2	20

Bolded numbers are out of control.

NC = not calculated

u = not detected above detection limit

ug/kg = micrograms per kilogram, ppb

ug/l = micrograms per liter, ppb

MS/MSD, Volatiles : Data for matrix spike/matrix spike duplicates (MS/MSD) are generated to determine long term precision and accuracy of the analytical method on various matrices and to demonstrate acceptable compound recovery by the laboratory at the time of sample analysis. These data alone cannot be used to evaluate the precision and accuracy of individual samples. However, when exercising professional judgement, this data should be used in conjunction with other available QC information.

APPENDIX F-1

VALIDATED ANALYTICAL DATA

FOR OLD DUMP SITE

Volatiles

[illegible]

Semivolatile Organics

U: undetected below the value given in the "reporting limit" column			
J: estimated concentration	J-: biased low		
B: present in blank	R: Data Rejected during data validation		
D: derived from 1:4 dilution of extract.			

Pesticides

[illegible]

1. 1
Fort Des Moines, Des Moines, Iowa
Old Dump Site
1996 Surface Soil Analytical Data

Volatile Organics

All Sample IDs begin with "ODS-"			Sample Location:	SS96-01-01	SS96-02-0	SS96-03-01	SS96-04-01	SS96-05-01	SS96-01-01	SS96-01-01
			Sample Depth (feet):	1'	1'	1'	1'	1'	1'	1'
			Date Sampled:	16-Jul-96	16-Jul-96	16-Jul-96	16-Jul-96	16-Jul-96	16-Jul-96	16-Jul-96
ANALYTE	UNITS	Reporting limit								
1. Acetone	µg/kg	50	u	u	u	u	u	u	u	u
2. Benzene	µg/kg	5	u	u	u	u	u	u	u	u
3. Bromodichloromethane	µg/kg	5	u	u	u	u	u	u	u	u
4. Bromoform	µg/kg	5	u	u	u	u	u	u	u	u
5. Bromomethane	µg/kg	10	u	u	u	u	u	u	u	u
6. 2-Butanone	µg/kg	50.0	u	u	u	u	u	u	u	u
7. Carbon disulfide	µg/kg	5.0	u	u	u	u	u	u	u	u
8. Carbon tetrachloride	µg/kg	5.0	u	u	u	u	u	u	u	u
9. Chlorobenzene	µg/kg	5.0	u	u	u	u	u	u	u	u
10. Chloroethane	µg/kg	10.0	u	u	u	u	u	u	u	u
11. Chloroform	µg/kg	5.0	u	u	u	u	u	u	u	u
12. Chloromethane	µg/kg	10.0	u	u	u	u	u	u	u	u
13. Dibromochloromethane	µg/kg	5.0	u	u	u	u	u	u	u	u
14. 1,1-Dichloroethane	µg/kg	5	u	u	u	u	u	u	u	u
15. 1,2-Dichloroethane	µg/kg	5	u	u	u	u	u	u	u	u
16. 1,1-Dichloroethene	µg/kg	5.0	u	u	u	u	u	u	u	u
17. <i>cis</i> -1,2-Dichloroethene	µg/kg	5.0	u	u	u	u	u	u	u	u
18. <i>trans</i> -1,2-Dichloroethene	µg/kg	5.0	u	u	u	u	u	u	u	u
19. 1,2-Dichloropropane	µg/kg	5.0	u	u	u	u	u	u	u	u
20. <i>cis</i> -1,3-Dichloropropene	µg/kg	5.0	u	u	u	u	u	u	u	u
21. <i>trans</i> -1,3-Dichloropropene	µg/kg	5.0	u	u	u	u	u	u	u	u
22. Ethylbenzene	µg/kg	5.0	u	u	u	u	u	u	u	u
23. 2-Hexanone	µg/kg	25.0	u	u	u	u	u	u	u	u
24. Methylene chloride	µg/kg	5.0	3.7 JB	5.2 B	u	4.0 JB	4.0 JB	4.9 JB	5.6 B	
25. 4-Methyl-2-pentanone	µg/kg	25.0	u	u	u	u	u	u	u	u
26. Styrene	µg/kg	5.0	u	u	u	u	u	u	u	u
27. 1,1,2,2-Tetrachloroethane	µg/kg	5	u	u	u	u	u	u	u	u
28. Tetrachloroethene	µg/kg	5.0	u	u	u	u	u	u	u	u
29. 1,1,1-Trichloroethane	µg/kg	5	u	u	u	u	u	u	u	u
30. 1,1,2-Trichloroethane	µg/kg	5.0	u	u	u	u	u	u	u	u
31. Trichloroethene	µg/kg	5.0	u	u	u	u	u	u	u	u
32. Toluene	µg/kg	5.0	u	u	u	u	u	u	u	u
33. Vinyl acetate	µg/kg	50.0	u	u	u	u	u	u	u	u
34. Vinyl chloride	µg/kg	10.0	u	u	u	u	u	u	u	u
35. Xylenes (total)	µg/kg	5.0	u	u	u	u	u	u	u	u
u: undetected below the value given in the "Reporting Limit" column										
J: estimated concentration										
B: present in blank										
Bold: value for 1,3-dichloropropene										

Table 1
Fort Des Moines, Des Moines, Iowa
Old Dump Site
1996 Surface Soil
Analytical Data

Semivolatile Organics

All Sample IDs begin with "ODS-"			Sample Location:	SS96-01-01	SS96-02-01	SS96-03-01	SS96-04-01	SS96-05-01	SS96-06-01	SS96-06-01-01
			Sample Depth (feet):	1'	1'	1'	1'	1'	1'	1'
			Date Sampled:	16-Jul-96	16-Jul-96	16-Jul-96	16-Jul-96	16-Jul-96	16-Jul-96	16-Jul-96
	ANALYTE	UNITS	Reporting limit							
1.	Phenol	µg/kg	190	u	<180	u	u	u	30J	u
2.	Bis(2-chloroethyl)ether	µg/kg	190	u	<180	u	u	u	u	u
3.	2-Chlorophenol	µg/kg	190	u	u	u	u	u	u	u
4.	1,3-Dichlorobenzene	µg/kg	190	RU	RU	RU	RU	u	u	u
5.	1,4-Dichlorobenzene	µg/kg	190	RU	RU	RU	RU	u	u	u
6.	Benzyl Alcohol	µg/kg	1900	u	u	u	u	u	u	u
7.	1,2-Dichlorobenzene	µg/kg	190	u	u	u	u	u	u	u
8.	2-Methylphenol	µg/kg	190	u	u	u	u	u	u	u
9.	2,2'-Oxybis(1-chloropropane)	µg/kg	190	u	u	u	u	u	u	u
10.	4-Methylphenol	µg/kg	190	u	u	u	u	u	u	u
11.	N-Nitroso-di-n-propylamine	µg/kg	190	u	u	u	u	u	u	u
12.	Hexachloroethane	µg/kg	190	u	u	u	u	u	u	u
13.	Nitrobenzene	µg/kg	190	u	u	u	u	u	u	u
14.	Isophorone	µg/kg	190	u	u	u	u	u	u	u
15.	2-Nitrophenol	µg/kg	360	u	u	u	u	u	u	u
16.	2,4-Dimethylphenol	µg/kg	360	u	u	u	u	u	u	u
17.	Benzoic Acid	µg/kg	1900	u	u	u	u	u	u	u
18.	Bis (2-chloroethoxy)methane	µg/kg	190	u	u	u	u	u	u	u
19.	2,4-Dichlorophenol	µg/kg	190	u	u	u	u	u	u	u
20.	1,2,4-Trichlorobenzene	µg/kg	190	u	u	u	u	u	u	u
21.	Naphthalene	µg/kg	190	80J-	90J-	RU	30J-	u	90J	130J
22.	4-Chloroaniline	µg/kg	360	u	u	u	u	u	u	u
23.	Hexachlorobutadiene	µg/kg	190	RU	RU	RU	RU	u	u	u
24.	4-Chloro-3-methylphenol	µg/kg	360	u	u	u	u	u	u	u
25.	2-Methylnaphthalene	µg/kg	190	160J	160J	u	40J	u	350	620
26.	Hexachlorocyclopentadiene	µg/kg	720	u	u	u	u	u	u	u
27.	2,4,6-Trichlorophenol	µg/kg	190	u	u	u	u	u	u	u
28.	2,4,5-Trichlorophenol	µg/kg	190	u	u	u	u	u	u	u
29.	2-Chloronaphthalene	µg/kg	190	u	u	u	u	u	u	u
30.	2-Nitroaniline	µg/kg	1900	u	u	u	u	u	u	u
31.	Dimethyl phthalate	µg/kg	190	u	u	u	u	u	u	u
32.	Acenaphthylene	µg/kg	190	40J	20J	u	u	u	60J	50J
33.	2,6-Dinitrotoluene	µg/kg	190	u	u	u	u	u	u	u
34.	3-Nitroaniline	µg/kg	1900	u	u	u	u	u	u	u
35.	Acenaphthene	µg/kg	190	30J R	u	u	u	u	30J	30J
u: undetected below the value given in the "reporting limit" column										
J: estimated concentration		J-: biased low								
B: present in blank		R: data rejected during data validation								

Table 1
Fort Des Moines, Des Moines, Iowa
Old Dump Site
1996 Surface Soil
Analytical Data

Semivolatile Organics

All Sample IDs begin with "ODS-"			Sample Location:	SS96-01-01	SS96-02-01	SS96-03-01	SS96-04-01	SS96-05-01	SS96-06-01	SS96-06-01-01
			Sample Depth (feet):	1'	1'	1'	1'	1'	1'	1'
			Date Sampled:	16-Jul-96	16-Jul-96	16-Jul-96	16-Jul-96	16-Jul-96	16-Jul-96	16-Jul-96
	ANALYTE	UNITS	Reporting limit							
36.	2,4-Dinitrophenol	µg/kg	1900	u	u	u	u	u	u	u
37.	4-Nitrophenol	µg/kg	1900	u	u	u	u	u	u	u
38.	Dibenzofuran	µg/kg	190	70J	70J	u	u	u	80J	90J
39.	2,4-Dinitrotoluene	µg/kg	190	u	u	u	u	u	u	u
40.	Diethyl phthalate	µg/kg	190	u	u	u	u	u	u	u
41.	4-Chlorophenyl phenyl ether	µg/kg	190	u	u	u	u	u	u	u
42.	Fluorene	µg/kg	190	50J	u	u	u	u	u	40J
43.	4-Nitroaniline	µg/kg	190	u	u	u	u	u	u	u
44.	4,6-Dinitro-2-methylphenol	µg/kg	1900	u	u	u	u	u	u	u
45.	N-Nitrosodiphenylamine	µg/kg	1900	u	u	u	u	u	u	u
46.	4-Bromophenyl phenyl ether	µg/kg	190	u	u	u	u	u	u	u
47.	Hexachlorobenzene	µg/kg	190	u	u	u	u	u	u	u
48.	Pentachlorophenol	µg/kg	1900	RU	RU	RU	RU	u	u	u
49.	Phenanthrene	µg/kg	190	950	480	50J	40J	40J	540	700
50.	Anthracene	µg/kg	190	160J	70J	u	u	u	110J	150J
51.	Di-n-butylphthalate	µg/kg	190	u	30J	u	u	u	60J	80J
52.	Fluoranthene	µg/kg	190	1110	480	80J	40J	50J	640	730
53.	Pyrene	µg/kg	190	1150	660	80J	50J	60J	670	760
54.	Butyl benzyl phthalate	µg/kg	190	u	u	u	u	u	u	u
55.	3,3'-Dichlorobenzidine	µg/kg	760	u	u	u	u	u	u	u
56.	Benzo(a)anthracene	µg/kg	190	780	370	40J	30J	30J	510	540
57.	Chrysene	µg/kg	190	730	410	60J	40J	40J	520	530
58.	Bis(2-ethylhexyl)phthalate	µg/kg	190	330B	200B	90BJ	120BJ	70BJ	80BJ	80BJ
59.	Di-n-octyl phthalate	µg/kg	190	u	u	u	u	u	u	u
60.	Benzo(b)fluoranthene	µg/kg	190	670	320	50J	40J	30J	480	500
61.	Benzo(k)fluoranthene	µg/kg	190	480	270	40J	30J	30J	350	350
62.	Benzo(a)pyrene	µg/kg	190	580	270	30J	30J	30J	380	400
63.	Indeno(1,2,3-cd)pyrene	µg/kg	190	430	170J	u	u	u	250	260
64.	Dibenz(a,h)anthracene	µg/kg	190	80J	50J	u	u	u	60J	70J
65.	Benzo(g,h,i)perylene	µg/kg	190	400	180	u	u	u	270	240
u: undetected below the value given in the "Reporting limit" column										
J: estimated concentration										
B: present in blank										

Tài liệu 1

Metals

[illegible]

APPENDIX F-2

VALIDATED ANALYTICAL DATA FOR BUILDING 67

Te 1

u: undetected below the value given in the "Reporting Limit" column

J: estimated concentration

B: present in blank

Bold: value for 1,3-dichloropropene

2. 1

u:	undetected below the value given in the "Reporting Limit" column		
J:	estimated concentration		
B:	present in blank		
Bold:	value for 1,3-dichloropropene		

Table 1

[illegible]

15-1

u: undetected below the value given in the "Reporting Limit" column
J: estimated concentration
B: present in blank
Bold: value for 1,3-dichloropropene

Tài liệu 1

All Sample IDs begin with "B67-" Sample Location:				SB96-0810	SB96-0902	SB96-0906	SB96-0910
		Sample Depth (feet):		10'	2'	6'	10'
		Date Sampled:		24-Jul-96	24-Jul-96	24-Jul-96	24-Jul-96
	ANALYTE	UNITS	Reporting limit				
1.	Chloromethane	µg/kg	10	u	u	u	u
2.	Vinyl chloride	µg/kg	10	u	u	u	u
3.	Bromomethane	µg/kg	10	u	u	u	u
4.	Chloroethane	µg/kg	10	u	u	u	u
5.	Acetone	µg/kg	50	u	u	u	u
6.	1,1-Dichloroethene	µg/kg	5.0	u	u	u	u
7.	Carbon disulfide	µg/kg	5.0	u	u	u	u
8.	Methylene chloride	µg/kg	5.0	40	u	u	39
9.	<i>trans</i> -1,2-Dichloroethene	µg/kg	5.0	u	u	u	u
10.	1,1-Dichloroethane	µg/kg	5.0	u	u	u	u
11.	<i>cis</i> -1,2-Dichloroethene	µg/kg	5.0	u	u	u	u
12.	Chloroform	µg/kg	5.0	u	u	u	u
13.	1,2-Dichloroethane	µg/kg	5.0	u	u	u	u
14.	Vinyl acetate	µg/kg	50	u	u	u	u
15.	2-Butanone	µg/kg	50	u	u	u	u
16.	1,1,1-Trichloroethane	µg/kg	5.0	u	u	u	u
17.	Carbon tetrachloride	µg/kg	5.0	u	u	u	u
18.	Benzene	µg/kg	5.0	u	u	u	u
19.	Trichloroethene	µg/kg	5.0	u	u	u	u
20.	1,2-Dichloropropane	µg/kg	5.0	u	u	u	u
21.	Bromodichloromethane	µg/kg	5.0	u	u	u	u
22.	<i>cis</i> -1,3-Dichloropropene	µg/kg	5.0	u	u	u	u
23.	<i>trans</i> -1,3-Dichloropropene	µg/kg	5.0	u	u	u	u
24.	1,1,2-Trichloroethane	µg/kg	5.0	u	u	u	u
25.	Dibromochloromethane	µg/kg	5.0	u	u	u	u
26.	Bromoform	µg/kg	5.0	u	u	u	u
27.	2-Hexanone	µg/kg	25	u	u	u	u
28.	Toluene	µg/kg	5.0	u	u	u	u
29.	4-Methyl-2-pentanone	µg/kg	25	u	u	u	u
30.	Tetrachloroethene	µg/kg	5.0	u	7.9	u	u
31.	Chlorobenzene	µg/kg	5.0	u	u	u	u
32.	Ethylbenzene	µg/kg	5.0	u	u	u	u
33.	Xylenes (total)	µg/kg	5.0	u	u	u	u
34.	Styrene	µg/kg	5.0	u	u	u	u
35.	1,1,2,2-Tetrachloroethane	µg/kg	5.0	u	u	u	u
u: undetected below the value given in the "Reporting Limit" column							
J: estimated concentration							
B: present in blank							
Bold: value for 1,3-dichloropropene							

**Fort Des Moines. Des Moines, Iowa
Former Building 67
1996 Soil Boring
Analytical Data**

Pesticides

All Sample IDs begin with "B67-"		Sample Location:	SB96-0102	SB96-0106	SB96-0110	SB96-0206	B96-0206-0	SB96-0208	SB96-0210	SB96-0306
		Sample Depth (feet):	2'	6'	10'	6'	6'	8'	10'	6'
		Date Sampled:	22-Jul-96	22-Jul-96	22-Jul-96	18-Jul-96	18-Jul-96	18-Jul-96	18-Jul-96	24-Jul-96
	ANALYTE	UNITS	Reporting limit							
1.	Aldrin	µg/kg	5	u	u	u	u	u	u	u
2.	Alpha BHC	µg/kg	5	u	u	u	u	u	u	u
3.	Beta BHC	µg/kg	10	u	u	u	u	u	u	u
4.	Delta BHC	µg/kg	5	u	u	u	u	u	u	u
5.	Lindane	µg/kg	5	u	u	u	u	u	u	u
6.	Chlordane	µg/kg	5	420	u	u	74	62	u	u
7.	4,4'-DDD	µg/kg	10	340	u	u	42	43	u	u
8.	4,4'-DDE	µg/kg	10	880	u	u	37	34	u	u
9.	4,4'-DDT	µg/kg	10	2200	u	u	35	39	u	u
10.	Dieldrin	µg/kg	10	1100	u	u	11	u	u	u
11.	Alpha Endosulfan	µg/kg	5	u	u	u	u	u	u	u
12.	Beta Endosulfan	µg/kg	10	u	u	u	u	u	u	u
13.	Endosulfan Sulfate	µg/kg	10	u	u	u	u	u	u	u
14.	Endrin	µg/kg	10	u	u	u	u	u	u	u
15.	Endrin Aldehyde	µg/kg	10	u	u	u	u	u	u	u
16.	Heptachlor	µg/kg	5	u	u	u	u	u	u	u
17.	Heptachlor Epoxide	µg/kg	5	u	u	u	u	u	u	u
18.	Methoxychlor	µg/kg	20	u	u	u	u	u	u	u
19.	Toxaphene	µg/kg	75	u	u	u	u	u	u	u
Bold: value for endosulfan										
u: undetected below the value given in the "Reporting limit" column										
J: estimated concentration										
B: present in blank										

Pesticides

[illegible]

Table 1
Fort Des Moines, Des Moines, Iowa
Former Building 67
1996 Soil Boring
Analytical Data

Pesticides

	All Sample IDs begin with "B67-"		Sample Location:	SB96-0810	SB96-0902	SB96-0906	SB96-0910
			Sample Depth (feet):	10'	2'	6'	10'
			Date Sampled:	24-Jul-96	24-Jul-96	24-Jul-96	24-Jul-96
	ANALYTE	UNITS	Reporting limit				
1.	Aldrin	µg/kg	5	u	u	u	u
2.	Alpha BHC	µg/kg	5	u	u	u	u
3.	Beta BHC	µg/kg	10	u	u	u	u
4.	Delta BHC	µg/kg	5	u	u	u	u
5.	Lindane	µg/kg	5	u	u	u	u
6.	Chlordane	µg/kg	5	100	u	u	u
7.	4,4'-DDD	µg/kg	10	57	u	u	u
8.	4,4'-DDE	µg/kg	10	13	u	u	u
9.	4,4'-DDT	µg/kg	10	75	u	u	u
10.	Dieldrin	µg/kg	10	87	u	u	u
11.	Alpha Endosulfan	µg/kg	5	u	u	u	u
12.	Beta Endosulfan	µg/kg	10	u	u	u	u
13.	Endosulfan Sulfate	µg/kg	10	u	u	u	u
14.	Endrin	µg/kg	10	u	u	u	u
15.	Endrin Aldehyde	µg/kg	10	u	u	u	u
16.	Heptachlor	µg/kg	5	u	u	u	u
17.	Heptachlor Epoxide	µg/kg	5	u	u	u	u
18.	Methoxychlor	µg/kg	20	u	u	u	u
19.	Toxaphene	µg/kg	75	u	u	u	u
Bold: value for endosulfan							
u: undetected below the value given in the "Reporting limit" column							
J: estimated concentration							
B: present in blank							

Herbicides

[illegible]

Herbicides

[illegible]

Herbicides

[illegible]

Metals

Metals

	All Sample IDs begin with "B67--"	Sample Location:	SB96-0310	SB96-0404	SB96-0406	SB96-0410	SB96-0502	SB96-0504	SB96-0510	SB96-0604	SB96-0606
		Sample Depth (feet):	10'	4'	6'	10'	2'	4'	10'	4'	6'
		Date Sampled:	24-Jul-96	23-Jul-96	23-Jul-96	23-Jul-96	23-Jul-96	23-Jul-96	23-Jul-96	23-Jul-96	23-Jul-96
	ANALYTE	UNITS	Reporting limit								
1.	Antimony	mg/kg	0.4	u	u	u	u	u	u	u	u
2.	Beryllium	mg/kg	0.1	0.6	0.8	0.7	0.5	0.6	0.7	0.6	0.7
3.	Cadmium	mg/kg	0.1	u	u	u	u	u	u	u	u
4.	Chromium	mg/kg	0.2	18.9	21	18.1	18.1	19.9	19.9	19.1	18.5
5.	Copper	mg/kg	0.6	18.8	20.6	20.8	16.4	20.7	21.7	18.1	15.9
6.	Lead	mg/kg	1	12	15.9	15.6	11.9	22.8	23.7	26.4	16.2
7.	Nickel	mg/kg	0.1	23.3	20.9	28.5	20.9	22.7	25	23.6	19.5
8.	Silver	mg/kg	0.2	u	u	u	u	u	u	u	u
9.	Thallium	mg/kg	0.6	u	u	u	u	u	u	u	u
10.	Zinc	mg/kg	0.1	70.6	72.9	78.9	68.3	84	93.9	76.6	61.5
11.	Arsenic	mg/kg	0.5	9.6	11.6	11.1	8.3	10.7	9.6	9.2	10.3
12.	Selenium	mg/kg	1	u	u	u	u	u	u	u	0.6
13.	Mercury	mg/kg	0.04	u	u	u	u	u	u	u	u
	u: undetected below the value given in the "Reporting limit" column										
	J: estimated concentration										
	B: present in blank										

Fort Des Moines, Des Moines, Iowa
Former Building 67
1996 Soil Boring Analytical Data

Metals

All Sample IDs begin with "B67-" Sample Location:			SB96-0608	SB96-0702	SB96-0706	SB96-0706-01	SB96-0708	SB96-0802	SB96-0806	SB96-0810	SB96-0902
Sample Depth (feet):			8'	2'	6'	6'	8'	2'	6'	10'	2'
Date Sampled:			23-Jul-96	23-Jul-96	23-Jul-96	23-Jul-96	23-Jul-96	24-Jul-96	24-Jul-96	24-Jul-96	24-Jul-96
	ANALYTE	UNITS	Reporting limit								
1.	Antimony	mg/kg	0.4	u	u	u	u	u	u	u	u
2.	Beryllium	mg/kg	0.1	0.7	0.6	0.6	0.6	0.5	0.7	0.7	0.6
3.	Cadmium	mg/kg	0.1	0.9	u	0.1	u	0.2	u	u	u
4.	Chromium	mg/kg	0.2	18.5	17.6	18.2	19.4	18.9	18	18.1	17.5
5.	Copper	mg/kg	0.6	22.8	14.5	20.6	21	19.4	16.3	21.1	17.7
6.	Lead	mg/kg	1	15	15.5	15.5	14.7	13.6	36.6	14.7	13.5
7.	Nickel	mg/kg	0.1	99.1	19	28.8	27.7	29.2	22.2	23.8	23.1
8.	Silver	mg/kg	0.2	u	u	u	u	u	u	u	u
9.	Thallium	mg/kg	0.6	u	u	u	u	u	u	u	u
10.	Zinc	mg/kg	0.1	65.2	61.6	77.2	78.2	69.8	76.8	66.5	57.9
11.	Arsenic	mg/kg	0.5	10.1	8.6	12	11.3	10.8	8.4	9.9	9
12.	Selenium	mg/kg	1	u	0.6	u	u	u	u	u	u
13.	Mercury	mg/kg	0.04	u	u	u	u	u	u	u	u
u: undetected below the value given in the "Reporting limit" column											
J: estimated concentration											
B: present in blank											

Fort Des Moines, Des Moines, Iowa
Former Building 67
1996 Soil Boring Analytical Data

Metals

All Sample IDs begin with "B67-"		Sample Location:		SB96-0906	SB96-0910
		Sample Depth (feet):		6'	10'
		Date Sampled:		24-Jul-96	24-Jul-96
	ANALYTE	UNITS	Reporting limit		
1.	Antimony	mg/kg	0.4	u	u
2.	Arsenic	mg/kg	0.5	10.3	9.6
3.	Beryllium	mg/kg	0.1	0.7	0.6
4.	Cadmium	mg/kg	0.1	u	u
5.	Chromium	mg/kg	0.2	21	17.7
6.	Copper	mg/kg	0.6	20.8	19.1
7.	Lead	mg/kg	1	17	13.7
8.	Mercury	mg/kg	0.04	u	u
9.	Nickel	mg/kg	0.1	22.1	24.9
10.	Selenium	mg/kg	1	u	u
11.	Silver	mg/kg	0.2	u	u
12.	Thallium	mg/kg	0.6	u	u
13.	Zinc	mg/kg	0.1	68.4	71.5
u: undetected below the value given in the "Reporting limit" column					
J: estimated concentration					
B: present in blank					

T- 1
Fort Des Moines s Moines, Iowa
Former Building 67
1996 Monitoring Well
Analytical Data

Volatile Organics

All Sample IDs begin with "B67-"		Sample Location:	GW96-0100	GW96-0101	GW96-0200
				(duplicate of 0100)	
		Date Sampled:	20-Aug-96	20-Aug-96	20-Aug-96
ANALYTE	UNITS	Reporting limit			
1. Chloromethane	µg/l	10	u	u	<100
2. Vinyl chloride	µg/l	10	u	u	<100
3. Bromomethane	µg/l	10	u	u	<100
4. Chloroethane	µg/l	10	u	u	<100
5. Acetone	µg/l	50	u	u	<500
6. 1,1-Dichloroethene	µg/l	2.0	u	u	<20
7. Carbon disulfide	µg/l	2.0	u	u	<20
8. Methylene chloride	µg/l	20.0	u	u	37
9. <i>trans</i> -1,2-Dichloroethene	µg/l	2.0	u	u	<20
10. 1,1-Dichloroethane	µg/l	2.0	u	u	<20
11. <i>cis</i> -1,2-Dichloroethene	µg/l	2.0	u	u	<20
12. Chloroform	µg/l	50.0	u	u	560
13. 1,2-Dichloroethane	µg/l	2.0	u	u	<20
14. Vinyl acetate	µg/l	25	u	u	<250
15. 2-Butanone (MEK)	µg/l	50	u	u	<500
16. 1,1,1-Trichloroethane	µg/l	50.0	u	u	<20
17. Carbon tetrachloride	µg/l	5.0	1.9J	2.3J	13J
18. Benzene	µg/l	2.0	u	u	28
19. Trichloroethene	µg/l	2.0	u	1.3J	<20
20. 1,2-Dichloropropane	µg/l	2.0	u	u	<20
21. Bromodichloromethane	µg/l	2.0	u	u	<20
22. <i>cis</i> -1,3-Dichloropropene	µg/l	2.0	u	u	<20
23. <i>trans</i> -1,3-Dichloropropene	µg/l	2.0	u	u	<20
24. 1,1,2-Trichloroethane	µg/l	2.0	u	u	<20
25. Dibromochloromethane	µg/l	2.0	u	u	<20
26. Bromoform	µg/l	2.0	u	u	<20
27. 2-Hexanone	µg/l	25	u	u	<250
28. Toluene	µg/l	2.0	u	u	<20
29. 4-Methyl-2-pentanone (MI)	µg/l	25	u	u	<250
30. Tetrachloroethene	µg/l	2.0	1.2J	1.3J	1100
31. Chlorobenzene	µg/l	2.0	u	u	<20
32. Ethylbenzene	µg/l	2.0	u	u	<20
33. Xylenes (total)	µg/l	2.0	u	u	<20
34. Styrene	µg/l	2.0	u	u	<20
35. 1,1,2,2-Tetrachloroethane	µg/l	2.0	u	u	<20
u: undetected below the value given in the "Reporting Limit" column					
J: estimated concentration					
B: present in blank					
Value for 1,3-dichloropropene					

Fort Des Moines, Iowa
Former Building 67
1996 Monitoring Well
Analytical Data

Semivolatile Organics

All Sample IDs begin with "B67"		Sample Location:	GW96-0100	GW96-0101 (duplicate of 0100)	GW96-0200
		Date Sampled:	20-Aug-96	20-Aug-96	20-Aug-96
ANALYTE	UNITS	Reporting limit			
1. Phenol	µg/l	5	u	u	5J
2. Bis(2-chloroethyl)ether	µg/l	10	u	u	u
3. 2-Chlorophenol	µg/l	5	u	u	6.4
4. 1,3-Dichlorobenzene	µg/l	5	u	u	1J
5. 1,4-Dichlorobenzene	µg/l	5	u	u	3J
6. Benzyl Alcohol	µg/l	50	u	u	u
7. 1,2-Dichlorobenzene	µg/l	5	u	u	u
8. 2-Methylphenol	µg/l	10	u	u	u
9. 2,2'-Oxybis(1-chloropropane)	µg/l	5	u	u	u
10. 4-Methylphenol	µg/l	10	u	u	u
11. N-Nitroso-di-n-propylamine	µg/l	5	u	u	u
12. Hexachloroethane	µg/l	5	u	u	u
13. Nitrobenzene	µg/l	10	u	u	u
14. Isophorone	µg/l	5	u	u	330D
15. 2-Nitrophenol	µg/l	100	u	u	u
16. 2,4-Dimethylphenol	µg/l	10	u	u	u
17. Benzoic Acid	µg/l	50	u	u	u
18. Bis (2-chloroethoxy)methane	µg/l	25	u	u	u
19. 2,4-Dichlorophenol	µg/l	5	u	u	170
20. Napthalene	µg/l	5	u	u	9.6
21. 1,2,4-Trichlorobenzene	µg/l	5	u	u	u
22. 4-Chloroaniline	µg/l	10	u	u	u
23. Hexachlorobutadiene	µg/l	5	u	u	u
24. 4-Chloro-3-methylphenol	µg/l	10	u	u	u
25. 2-Methylnaphthalene	µg/l	10	u	u	u
26. Hexachlorocyclopentadiene	µg/l	20	u	u	u
27. 2,4,6-Trichlorophenol	µg/l	5	u	u	13
28. 2,4,5-Trichlorophenol	µg/l	5	u	u	92
29. 2-Chloronaphthalene	µg/l	5	u	u	u
30. 2-Nitroaniline	µg/l	50	u	u	u
31. Dimethyl phthalate	µg/l	5	u	u	u
32. Acenaphthylene	µg/l	5	u	u	u
33. 2,6-Dinitrotoluene	µg/l	10	u	u	u
34. 3-Nitroaniline	µg/l	50	u	u	u
35. Acenaphthene	µg/l	5	u	u	u
u: undetected below the value given in the "reporting limit" column					
J: estimated concentration					
B: present in blank					
D: derived from 1:4 dilution of extract.					

1. 1
Fort Des Moines, Des Moines, Iowa
Former Building 67
1996 Monitoring Well
Analytical Data

Semivolatile Organics

	All Sample IDs begin with "B67-"		Sample Location:	GW96-0100	GW96-0101	GW96-0200
					(duplicate of 0100)	
			Date Sampled:	20-Aug-96	20-Aug-96	20-Aug-96
	ANALYTE	UNITS	Reporting limit			
36.	2,4-Dinitrophenol	µg/l	50	u	u	u
37.	4-Nitrophenol	µg/l	50	u	u	u
38.	Dibenzofuran	µg/l	5	u	u	u
39.	2,4-Dinitrotoluene	µg/l	10	u	u	u
40.	Diethyl phthalate	µg/l	5	u	u	1J
41.	4-Chlorophenyl phenyl ether	µg/l	5	u	u	u
42.	Fluorene	µg/l	5	u	u	u
43.	4-Nitroaniline	µg/l	50	u	u	u
44.	4,6-Dinitro-2-methylphenol	µg/l	50	u	u	u
45.	N-Nitrosodiphenylamine	µg/l	5	u	u	u
46.	4-Bromophenyl phenyl ether	µg/l	5	u	u	u
47.	Hexachlorobenzene	µg/l	5	u	u	u
48.	Pentachlorophenol	µg/l	50	u	u	5J
49.	Phenanthrene	µg/l	5	u	u	u
50.	Anthracene	µg/l	5	u	u	u
51.	Di-n-butylphthalate	µg/l	5	u	u	u
52.	Fluoranthene	µg/l	5	u	u	u
53.	Pyrene	µg/l	5	u	u	u
54.	Butyl benzyl phthalate	µg/l	5	1J	2J	2J
55.	3,3'-Dichlorobenzidine	µg/l	20	u	u	u
56.	Benzo(a)anthracene	µg/l	5	u	u	u
57.	Chrysene	µg/l	5	u	u	u
58.	Bis(2-ethylhexyl)phthalate	µg/l	5	5.8B	7.3B	5BJ
59.	Di-n-octyl phthalate	µg/l	5	u	u	u
60.	Benzo(b)fluoranthene	µg/l	5	u	u	u
61.	Benzo(k)fluoranthene	µg/l	5	u	u	u
62.	Benzo(a)pyrene	µg/l	5	u	u	u
63.	Indeno(1,2,3-cd)pyrene	µg/l	5	u	u	u
64.	Dibenz(a,h)anthracene	µg/l	5	u	u	u
65.	Benzo(g,h,i)perylene	µg/l	5	u	u	u
u: undetected below the value given in the "Reporting limit" column						
J: estimated concentration						
B: present in blank						

Fort Des Moines, Des Moines, Iowa
Former Building 67
1996 Monitoring Well Analytical Data

Metals

All Sample IDs begin with "B67-"		Sample Location:		GW96-0100	GW96-0101	GW96-0200
		Date Sampled:		20-Aug-96	(duplicate of 0100) 20-Aug-96	20-Aug-96
	ANALYTE	UNITS	Reporting limit			
1.	Antimony	ug/l	50	u	u	u
2.	Beryllium	ug/l	2	2	u	u
3.	Cadmium	ug/l	4	u	u	u
4.	Chromium	ug/l		255	161	214
5.	Copper	ug/l		42	22	37
6.	Lead	ug/l		22	9	15
7.	Nickel	ug/l		177	113	167
8.	Silver	ug/l	5	u	u	u
9.	Thallium	ug/l	100	u	u	u
10.	Zinc	ug/l		116	60	241
11.	Arsenic	ug/l		17	8	16
12.	Selenium	ug/l		4	3	2
13.	Mercury (inorganic)	ug/l	0.2	u	u	u
u: undetected below the value given in the "Reporting limit" column						
J: estimated concentration						
B: present in blank						
#: lead value is an "action value", not Region 3 RBC						

Table 1
Fort Des Moines, Des Moines, Iowa
Former Building 67
1996 Monitoring Well
Analytical Data

Pesticides

	All Sample IDs begin with "B67-"		Sample Location:	GW96-0100	GW96-0101	GW96-0200
					(duplicate of 0100)	
			Date Sampled:	20-Aug-96	20-Aug-96	20-Aug-96
	ANALYTE	UNITS	Reporting limit			
1.	Aldrin	µg/l	0.05	u	u	<2
2.	Alpha BHC	µg/l	0.05	u	u	83
3.	Beta BHC	µg/l	0.1	u	u	4
4.	Delta BHC	µg/l	0.05	u	u	5
5.	Lindane	µg/l	0.05	u	u	17
6.	Chlordane	µg/l	0.05	u	u	<2
7.	4,4'-DDD	µg/l	0.1	u	u	<3
8.	4,4'-DDE	µg/l	0.1	u	u	<3
9.	4,4'-DDT	µg/l	0.1	u	u	<3
10.	Dieldrin	µg/l	0.1	u	u	<3
11.	Alpha Endosulfan	µg/l	0.1	u	u	<2
12.	Beta Endosulfan	µg/l	0.1	u	u	<3
13.	Endosulfan Sulfate	µg/l	0.1	u	u	<3
14.	Endrin	µg/l	0.1	u	u	<3
15.	Endrin Aldehyde	µg/l	0.1	u	u	<3
16.	Heptachlor	µg/l	0.05	u	u	<2
17.	Heptachlor Epoxide	µg/l	0.1	u	u	<2
18.	Methoxychlor	µg/l	0.2	u	u	<6
19.	Toxaphene	µg/l	0.75	u	u	<23
	Bold: value for endosulfan					
	u: undetected below the value given in the "Reporting Limit" column					
	J: estimated concentration					
	B: present in blank					

Herbicides

[illegible]

APPENDIX G

GEOPHYSICAL INVESTIGATION AT THE FORT DES MOINES DUMP SITE

GEOPHYSICAL INVESTIGATION

AT THE

FORT DES MOINES DUMP SITE

Des Moines, Iowa

for

Braun Intertec Corporation

Minneapolis, Minnesota

June, 1996

GEOSPHERE MIDWEST

Brooklyn Park, Minnesota

GEOSPHERE MIDWEST

June 25, 1996

Mr. Loren W. Braun
Braun Intertec Corporation
P.O. Box 39108
6801 Washington Avenue South
Minneapolis, MN 55439-0108

**Re: Fort Des Moines Dump Site: Des Moines, Iowa: Geophysical Report Transmittal
Geosphere Midwest Project #96-516**

Dear Mr. Braun:

We have completed our report for the Fort Des Moines Dump Site project, entitled "Geophysical Investigation at the Fort Des Moines Dump Site, Des Moines, Iowa."

This report documents the results of our magnetometry and EM61 surveys, which were performed on May 21 to 24, 1996. The geophysical investigations identified two landfills.

A total of 10 copies of this report have been sent to your company. Please call if you have any questions.

Sincerely,



Don Johnson
Project Manager

Enclosures

GEOPHYSICAL INVESTIGATION

AT THE

FORT DES MOINES DUMP SITE

Des Moines, Iowa

for

Braun Intertec Corporation

Minneapolis, Minnesota

June 1996

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EXECUTIVE SUMMARY

Geophysical investigations, consisting of magnetometer and EM61 metal detector surveys, were performed by Geosphere Midwest at the Old Fort Des Moines Dump site, Des Moines, Iowa from May 21 to 24, 1996. Data were collected along north-south grid lines spaced 10 feet apart. Magnetometer data were collected at intervals of 2.5 feet and EM61 data were collected at intervals of 0.6 feet. The area investigated covered approximately 5 acres.

Two landfills were identified by the investigation. The larger one appears to consist of two landfill cells separated by a narrow area of less concentrated or thinner landfill. The smaller landfill is located immediately south of the larger one. Neither could be fully defined because they both appear to extend into the lake and thick brush prevented data collection in portions of the site. Some scattered metal is present in the remainder of the site. Similar results were obtained by both geophysical methods.

1 INTRODUCTION

1.1 LOCATION AND DESCRIPTION

Geophysical investigations were performed at the old Fort Des Moines Dump Site from May 21 to May 24, 1996. The Fort Des Moines Dump site is located south of the City of Des Moines, Iowa (Figure 1.1). It operated for approximately 65 years, from 1901 to the mid 1960's. The land that the dump occupies was transferred to Polk County and the City of Des Moines in 1971. A portion of the landfill was encountered during construction of a dam that forms a small lake on the property. The dump is expected to contain domestic waste, construction debris and possibly small arms ammunition debris.

Investigation consisted of magnetometer and EM61 metal detector surveys. The area covered is a point of land extending into the lake. A gravel road leads to this point that has a small parking lot, boat ramp and dock. Figure 1.2 shows the survey limits. At most of the time during the investigation, cars were present in the parking lot while their owners fished. The parking lot was investigated with minimal interference from the parked cars by skipping portions of the lot where cars would interfere and doing them later after the cars left.

The area covered by the investigation covered approximately 5 acres. Much of the site was cut grass with widely spaced trees. Some of the site, however, was covered with thick brush and trees and could not be investigated.

1.2 PURPOSE

Magnetometer and EM61 metal detector surveys were performed at the site to delineate the limits of the old dump. Within the limits of the landfill, higher concentrations of waste have been distinguished from areas where the waste is apparently less concentrated.

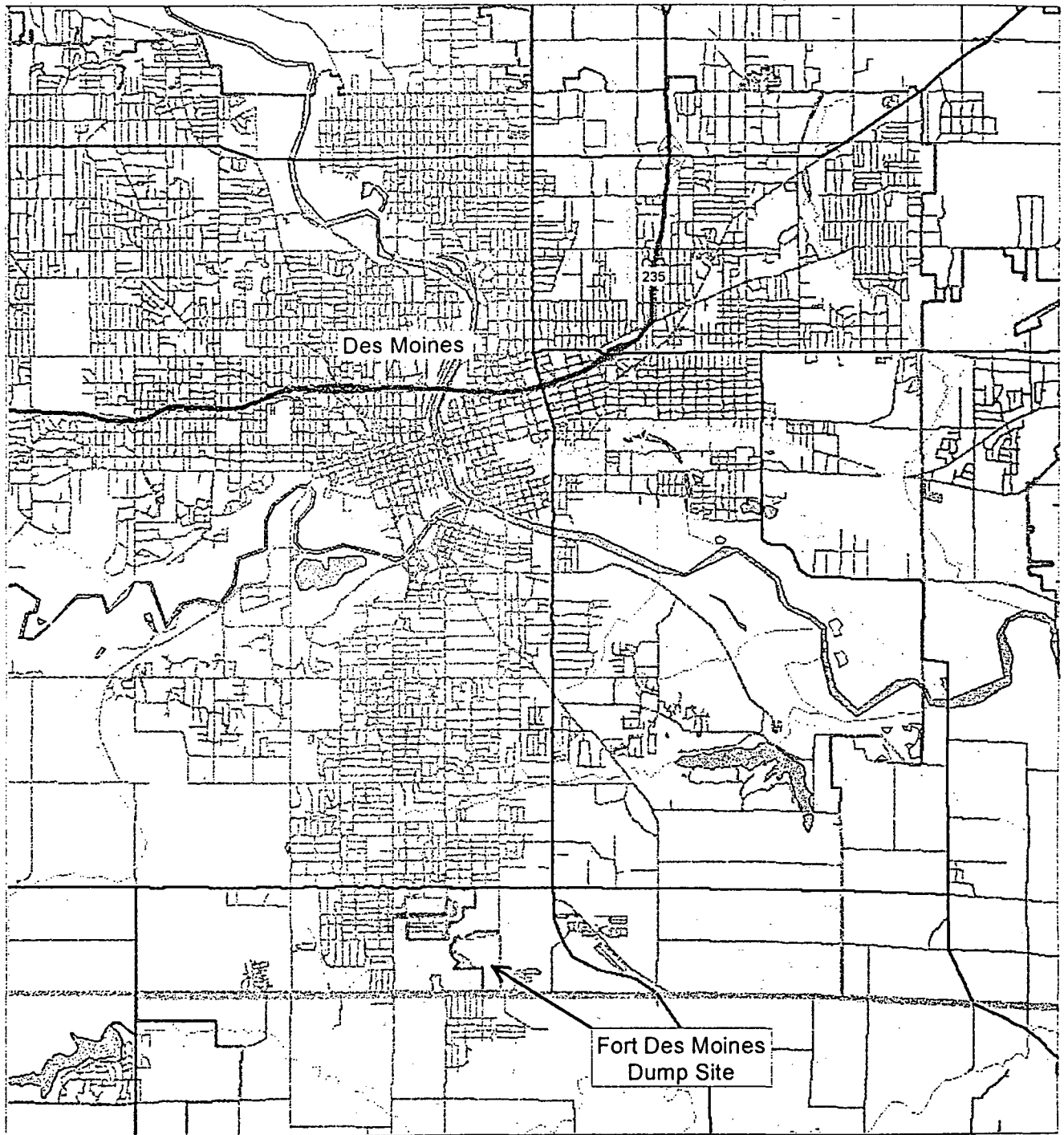
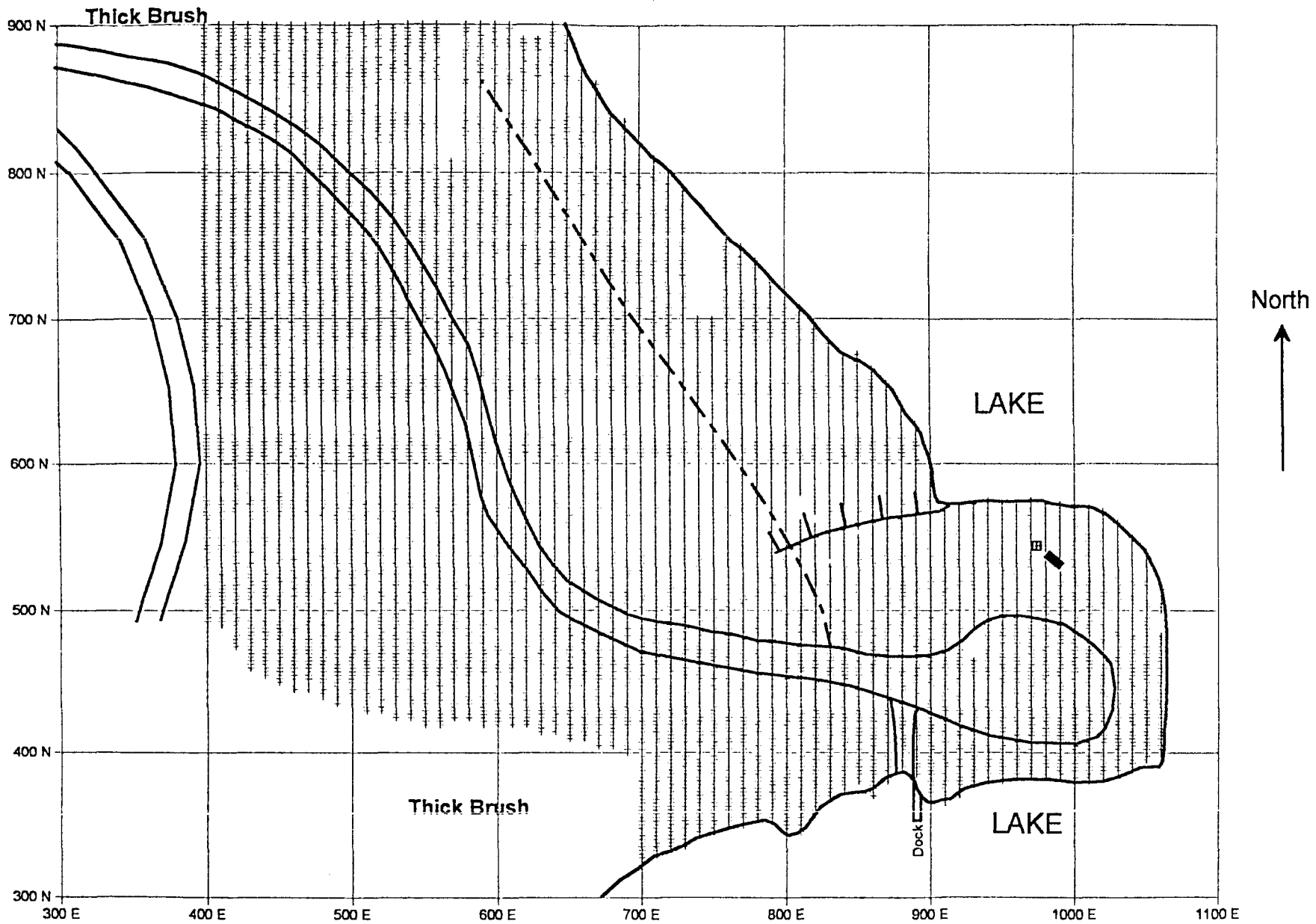


Figure 1.1
Site Location Map
Old Fort Des Moines Dump Site
Des Moines, Iowa



LEGEND

- Footpath
- Steep Bank
- Magetometer Data Point
- BBQ Grill
- Picnic Table

Figure 1.2
Extent of Investigation
Old Fort Des Moines Site, Iowa

2 GEOPHYSICAL METHODS

Two geophysical methods were used to investigate the site, both of which are used to locate metal. These included magnetometry using a fluxgate magnetometer in the gradiometer configuration and metal detection using the Geonics EM61.

2.1 MAGNETIC METHOD

The magnetometer is used to measure variations in the intensity of the earth's magnetic field. Variations in this relatively uniform field may be caused by the weak natural magnetic properties within the underlying soil and rock or caused by the much stronger magnetic characteristics of buried iron or steel objects. Local geology does not include naturally magnetic rock so any variations observed at these sites can only be attributed to metal objects. The size and shape of a specific local anomaly is related to many different factors. The anomaly caused by a metal object is primarily due to induced and permanent magnetism. Induced magnetism of an object is the magnetic field caused by its presence in an external (the earth's) field. The greater the mass of a metal object, the greater is the induced magnetic anomaly. Similarly, the strength of the object's magnetic anomaly at the ground's surface is inversely related to its depth. Permanent magnetism does not depend on an external field and may act in conjunction with or against the induced magnetic field of the object. Further, the target's shape, orientation in the earth's field, and its state of deterioration affect anomaly characteristics. Accordingly, the magnetic responses of similar objects may vary over a wide range, making definitive identification of the source object difficult or impossible. A magnetometer does not respond to non-ferrous metals such as aluminum, copper, tin, and brass.

The earth's magnetic field intensity changes throughout the day with sunspots and ionospheric conditions. This variation, called diurnal noise, produces unwanted noise and can affect local magnetic measurements. One way to remove this noise is to use a base station that monitors the change in magnetic field throughout the day. Base station readings are then used to correct the survey readings. Another way to deal with diurnal noise is to measure the vertical gradient of the magnetic field. The vertical magnetic gradient is measured using two sensors (mounted vertically with one another); such an instrument is called a gradiometer. The vertical gradient method provides two advantages over a single sensor method. These are elimination of diurnal variation and improvement of lateral resolution.

2.2 EM61 METAL DETECTION METHOD

The Geonics EM61 metal detector was used to detect and map zones of metallic anomalies. The EM61 operates by transmitting a pulsed primary electromagnetic field that induces eddy currents in the ground as well as in nearby metallic objects. The eddy currents produce a secondary field that decays with time after the termination of each primary field pulse. The rate of decay of the

secondary field is dependant on the electrical conductivity of each object within range of the instrument, with the decay progressing more slowly in the more conductive objects. The receiver measures the strength of the secondary field produced by the eddy currents at a sufficiently long time after the start of the decay that the current induced in the ground has fully dissipated and only the eddy currents in nearby metal is measured. Measurements are made at two different delay times to provide an indication of relative depth of metal objects. The system is sensitive to both ferrous and non-ferrous metal.

The EM61 can detect a single 55-gallon drum at a depth slightly over 10 feet. The response is a single sharp peak, providing high resolution data that can be used to accurately locate relatively small metal objects. Larger quantities of drums (and other metal) can be detected at greater depths. It is relatively insensitive to nearby cultural features such as buildings, fences and power lines.

The EM61 measurements can be made manually, by a wheel, or on a time basis. The wheel was used for these investigations, resulting in readings approximately every 0.65 feet along each survey line.

3 DATA ACQUISITION

3.1 SITE GRID

A grid was established at the site prior to data collection. A north-south base line was established at the west side of the site and marked with 100-foot intervals. It was assigned grid coordinate 300 east. An east-west base line was then staked using a prism to accurately turn a right angle off the north-south base line. This line was assigned grid value 500 north and flagged at 10-foot intervals. Additional east-west grid lines at 100-foot spacings were laid out and flagged at 10-foot intervals. In areas of taller weeds or poorer visibility, additional east-west grid lines were flagged. Geophysical data were then collected along north-south grid lines by walking between flagged grid locations.

3.2 MAGNETOMETER

The magnetic measurements were made with a FEREX fluxgate magnetometer system used in the gradiometer mode. Readings, in units of gammas/foot, were made at 2½-foot intervals along north-south grid lines 10 feet apart. Station locations along each line were determined by pacing between the flagged grid locations. Magnetic values, along with grid coordinates, were stored in a digital data logger (Omnidata Polycorder) for subsequent transfer to computer for processing and plotting. Data were processed by editing the data to remove duplicate data and contoured in color using Surfer for Windows software.

3.3 EM61

EM61 readings, in units of millivolts, were made along the same grid lines as magnetic readings. Readings were triggered by a wheel, resulting in measurements being made at intervals of 0.65 feet. Data, including grid coordinates, were recorded on a digital data logger (Omnidata Polycorder) and periodically transferred to a computer for later processing and plotting. EM61 data were processed and contoured in the same manner as the magnetometer data.

4 SURVEY RESULTS AND CONCLUSIONS

4.1 MAGNETOMETER SURVEY

Contours of the magnetic data are shown in Figure 4.1. Background appears as light yellow in the figure. Anomalous areas, both magnetic highs and lows, indicate metal and appear in Figure 4.1 as other colors.

Two areas of concentrations of metal are interpreted as buried landfill. These results are shown in Figure 4.2. The largest of the landfill areas is primarily north and east of the dirt road leading to the parking area on the point. East of grid line 800E, the landfill is present on both sides of the road. A small area within the interpreted landfill limits is characterized by weaker and more widely spaced anomalies. It is interpreted as either thinner or less concentrated landfill material. This has been identified in Figure 4.2 as less concentrated landfill. Its shape and location suggests the landfill consists of two landfill cells joined by a thinner landfill section. The landfill appears to extend into the lake and its limits beyond the lake shore could not be determined.

A second, smaller interpreted landfill is located centered at approximately 750E/375N. The western extent of this feature could not be determined because thick brush prevented data collection in that area. It also appears that the landfill extends into the lake and for that reason, its southern limit could not be determined.

Distinct anomalies in the northwest portion of the site, the strongest centered approximately at grid coordinates 525E/900N, appear to be related to surficial scrap metal. The full extent of this feature could not be determined because of thick brush, but scrap metal was visible within the brush. Because of the surface metal, it cannot be established whether buried metal is also present.

The remainder of the site is characterized by scattered pieces of buried metal. Because the metal is widely spaced with background conditions between the metal, is not characterized as landfill. Many of the trees planted in the western part of the area investigated had metal anomalies associated with them. The reason for a piece of metal to be present at so many of the trees is not known.

4.2 EM61 METAL DETECTION SURVEY

Contours of the EM61 metal response are presented in Figure 4.3. The stronger the metal response is, the larger and/or shallower the metal causing the anomaly. The strongest anomalies appear as purple, red and yellow in the figure. The EM61 antenna is larger and has more trouble going through brush conditions than the magnetometer resulting in somewhat less coverage. The white areas within the contours are areas where data could not be collected because of brush. The interpreted results of the EM61 survey are shown in Figure 4.4. The EM61 results are very similar

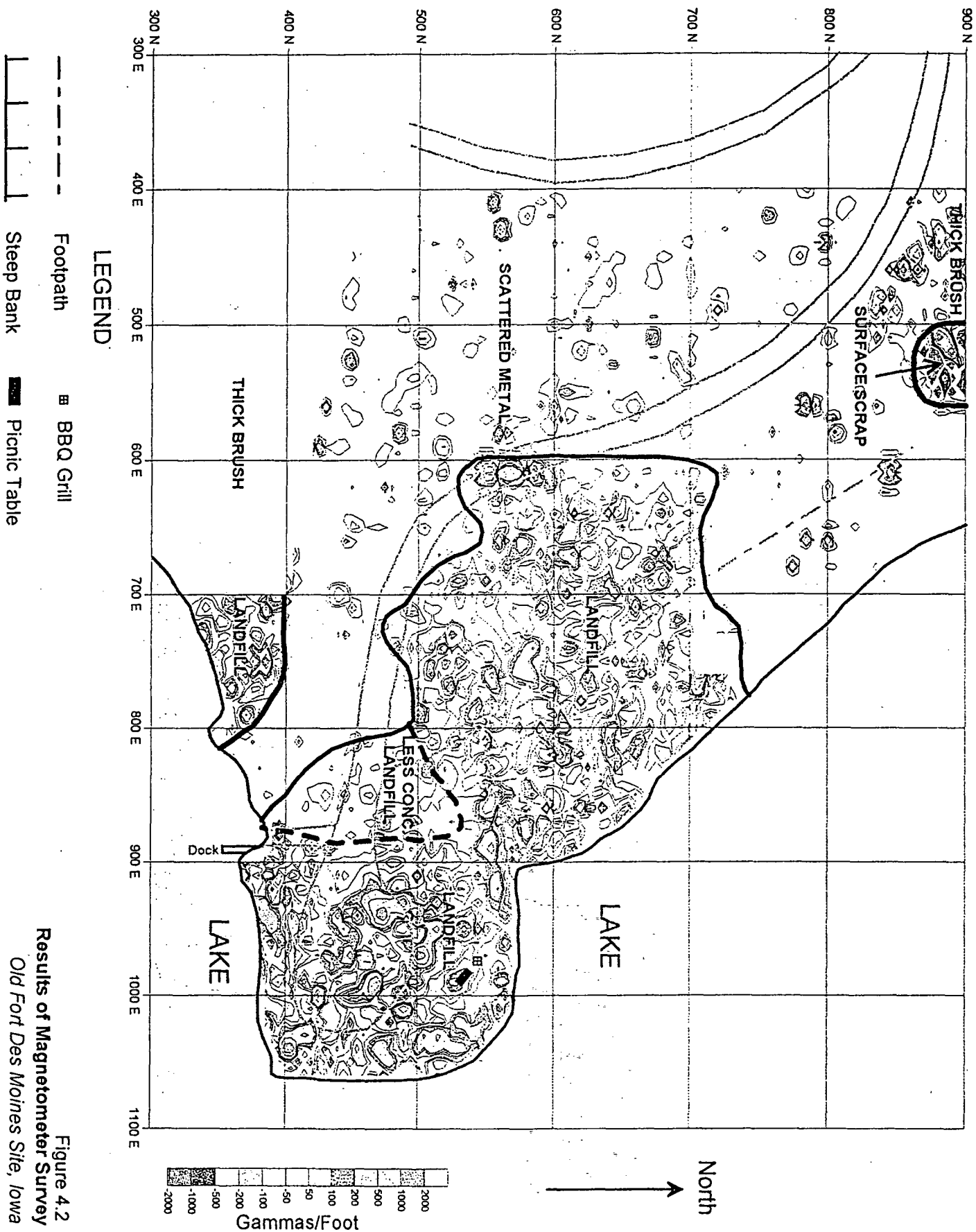


Figure 4.2
Results of Magnetometer Survey
Old Fort Des Moines Site, Iowa

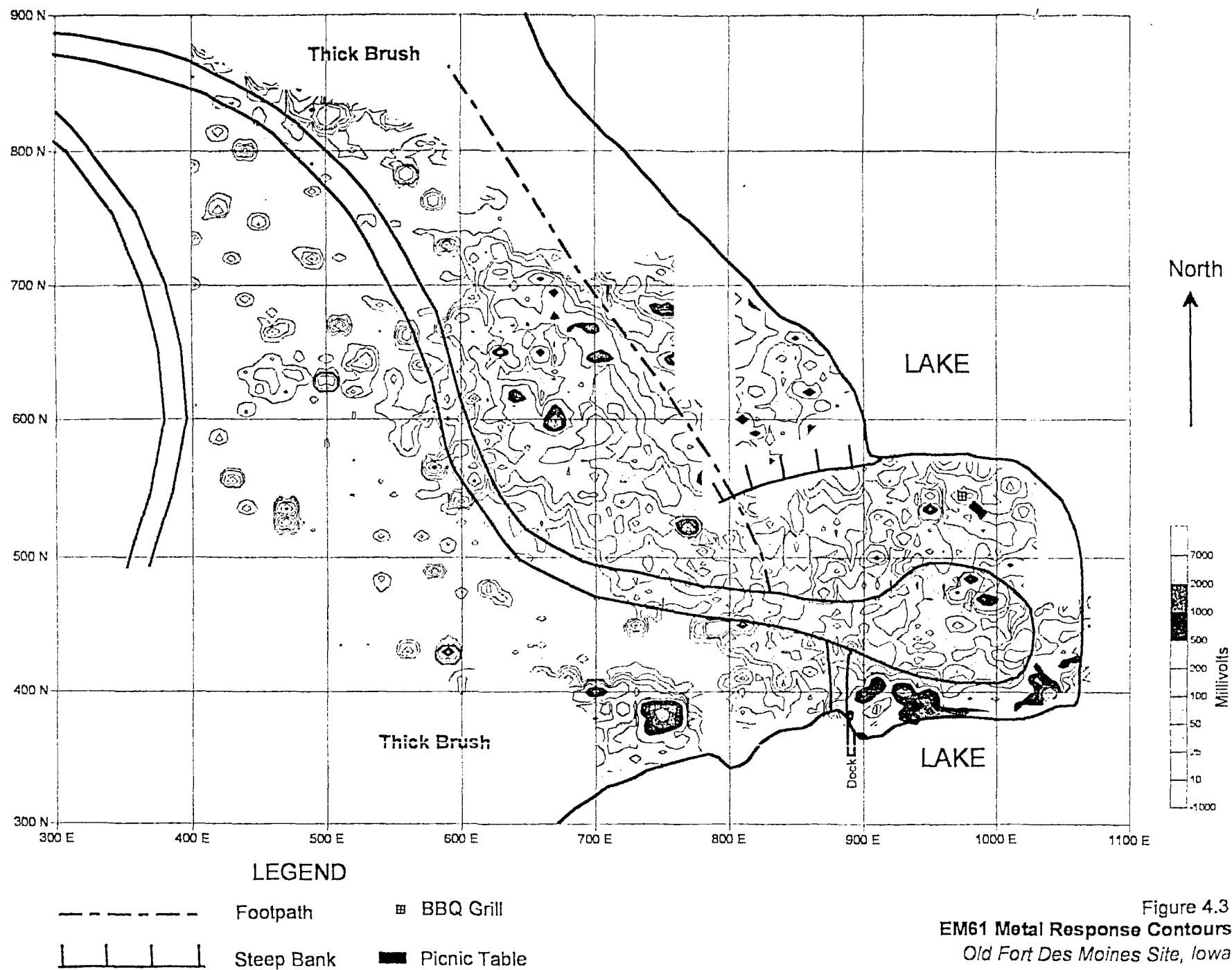


Figure 4.3
EM61 Metal Response Contours
 Old Fort Des Moines Site, Iowa

